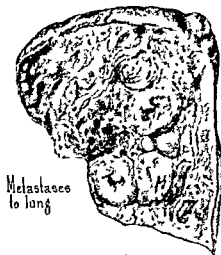


# CLINICAL UROLOGY



Metastases  
to lung



Metastases to  
brain



Metastases to liver



Primary lesion  
in testis  
(chorionepithelioma)



Metastases to  
kidney

CHORIONEPITHELIOMA OF THE TESTIS WITH WIDESPREAD METASTASES TO THE LUNG BRAIN  
LIVER, AND KIDNEY (SEE PAGE 456) (KIRWIN'S CASE)

# Clinical Urology

BY

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DRAWINGS BY

WILLIAM P. DIDUSCH

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Second Edition

Volume I



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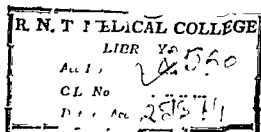
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## DEDICATION

*This book is dedicated to the memory*

*of the late*

JAMES BUCHANAN BRADY

*and*

GUSTAVUS L. LAWRENCE

*and to*

MESSRS. CHARLES C. WRIGHT AND ALFRED M. BUSIEL AND  
DR. RALPH O. CLOCK

*whose generous bequests have made possible*

*the clinical and research activities*

*of the Department of Urology (James Buchanan Brady Foundation)*

*of the New York Hospital*

## PREFACE

Much time and thought have been expended in the preparation of this second edition of **CLINICAL UROLOGY**. The many new developments in urological diagnosis and treatment since the publication of the first edition, in 1940, have necessitated a thorough revision of much of the original material, as well as the addition of considerable new subject matter. Unfortunately, the exigencies of war have made it impossible to include some three hundred new illustrations of operative technics, pathological specimens, and recently designed instruments. These pictures, drawn by Mr. William P. Didusch, will be held in reserve and utilized when possible. Each new operation and instrument has, however, been described with a detail that should enable the serious student to grasp the subject matter without difficulty.

Since the appearance of the first edition, particularly great strides have been made in the application of chemotherapy in the practice of urology. This subject is discussed fully, especial attention being paid to the newer sulfa drugs and penicillin. Sections of the book that have been augmented and greatly improved include those dealing with syphilitic chancre, carcinoma of the prostate gland, the hormonal treatment of the prostate, sarcoma of the prostate, renal cysts, urogenital tuberculosis, plastic induration of the penis, obstructions at the ureteropelvic junction, the chemotherapeutic management of the various urogenital infections, including gonorrhea, uretero-intestinal anastomosis, the preoperative and postoperative treatment of the prostatic case, and the postoperative care of the renal case. New subjects added to the book include the renal factor in arterial hypertension, the surgical treatment of arterial hypertension, calyceal resection, the castration treatment of prostatic carcinoma, aneurysm of the renal artery, hydrocalyx, a new theory of etiology and a new operation for vesical papillomatosis, automatic tidal drainage of the bladder, continuous (fractional) spinal anesthesia in urology, dried blood plasma therapy, new diets in urology, especially for calculus, and *methods of dissolving certain types of urinary calculi*.

As with the first edition, this book is written primarily for the medical student, the general practitioner, and the general surgeon. We believe,

however, that it will also prove a useful reference work to the trained urologist. Its purpose is to give a practical survey of the nature, diagnosis, and treatment of the anomalies and diseases of the genito-urinary organs according to the present state of knowledge. It is at once a manual of operative technic and a comprehensive, though necessarily brief, exposition of the embryology, anatomy, histology, and pathology of the urogenital tract. The urological diseases of women and children are considered, as well as those of the adult male.

Although we have drawn frequently and freely from the experiences and researches of others, as recorded in the vast literature of modern urology, the opinions expressed are mainly the result of our own experience in hospital and private practice over a period of many years.

A word regarding the arrangement of the text may be helpful. We have retained the structural form employed in the first edition, since we believe that this simplicity of arrangement increases the practical value of the material. Chapters I to V are devoted to the general diagnostic procedures of urology, and include separate chapters on history taking and physical examination, examination of the urine, tests of renal function, instrumental examination, and roentgenography of the genito-urinary tract. Then follows a chapter on anesthesia in urology. Beginning with Chapter VII, the organs of the urogenital tract are taken up in their anatomical sequence from without inward, and considered as to their embryology, anatomy, anomalies, physiology, injuries, and diseases. The architecture of each section is the same, making it easy to find facts desired. Anomalies, injuries, and diseases are each described from the standpoints of etiology, pathology, symptoms, diagnosis and differential diagnosis, prognosis, and treatment—both surgical and non-surgical. Of special usefulness we believe, are the section dealing with the splendid work done by Dr. Stanley L. Wang in the treatment of inoperable and postoperative urogenital tuberculosis, and the chapter on gonorrhea which includes the recent advances with chemotherapy and physiotherapy. Chapters on radiation therapy in urology, and dried blood plasma therapy complete the book.

The surgical aspects of urology are given particular attention. The procedures described have proved their worth and practicability in an extensive personal experience and in the hands of our colleagues. Most of the surgical technics have been illustrated step by step and fully explained in the legends accompanying the drawings, thereby doing away with the need for lengthy descriptions of operations in the text.

These illustrations, which have been beautifully executed by Mr William P Didusch from drawings made at the operating table, add enormously to the lucidity and value of the presentation, and should make this work of particular value to surgeons far removed from metropolitan surgical centers, who find it necessary to perform occasional urological operations and desire to keep abreast of the latest phases of urological practice. Our inability to include new illustrations of surgical technics in the present edition has, unfortunately, made it necessary, in a number of important instances, to resort to the unsatisfactory method of lengthy textual description. Since photomicrographs and pathological sections are available in most works on urology, these have been reduced to a minimum so as to allow more space for illustrations of surgical technic.

Extensive, though by no means complete, bibliographies have been appended to the chapters. All literary references noted in the text have been included in these bibliographies, thereby enabling the reader, if he so desires, to look up original sources and thus obtain more complete information than can possibly be furnished him within the confines of a single book.

In response to many requests, the complete index of the contents has been included in each of the two volumes. Another improvement is the inclusion in the index of Mr Didusch's drawings, as well as the other illustrations.

A certain amount of repetition will be found in different chapters of the book. This repetition is intentional, and for the purpose of avoiding constant, annoying cross-reference to other portions of the book, with consequent loss of time to the student.

Although we have made every effort to be accurate, and have scrupulously endeavored to give credit where credit is due, errors may inadvertently have been made in quoting from other authors, or there may have been occasional failure to acknowledge our indebtedness to others. For any such oversight we ask indulgence, and hereby gladly express our gratitude to those of our predecessors and contemporaries who have made possible the present state of knowledge of urological diseases and their treatment.

Expression of appreciation is due to our colleagues on the staff of the Department of Urology (James Buchanan Brady Foundation) of the New York Hospital, and to others, for permission to use illustrative cases and pathological material, as accredited to them in the proper places in the text and in the legends accompanying the illustrations. We also wish to

thank the authorities of the New York Hospital, who have made available certain records of the *Brady Foundation* for use in this work. And—lest we forget—to the memory of that warm hearted philanthropist, James Buchanan Brady, whose desire to help suffering humanity prompted him to establish the Foundation, we again pay grateful tribute. Mr Robert L. Gordon and Mr Richard C. Crowley, executors of Mr Brady's estate, have sustained their interest in all of the Foundation's activities, and we are most grateful to them.

Grateful acknowledgment is due to Mrs Amy Pope Shirk for translations from foreign languages and assistance with research, and to Mr Harry Blumenthal, radiographer at the New York Hospital, for valuable advice in the selection and arrangement of the roentgenograms.

We wish particularly to express our gratitude to Miss Ebba M. Rogstad for her ever present loyalty and unselfish devotion to the preparation of this book. Without her intelligent cooperation and editorial supervision, this publication could not have been completed at this time. To her should be credited the literary form of the entire work, as well as the excellent index of text and illustrations.

Finally, we wish to thank the publishers, who have spared no effort to make the book a success in every way.

O S L  
T J K.

## CONTENTS OF VOLUMES I AND II

### VOLUME I

#### CHAPTER I

##### HISTORY TAKING AND PHYSICAL EXAMINATION

History taking	1
Physical examination	11

#### CHAPTER II

##### EXAMINATION OF THE URINE

Collection of urinary specimens	21
The clinical tests	24
The physical tests	27
The chemical tests	30
The microscopic tests	35
The bacteriological tests	41
Animal inoculation tests	42

#### CHAPTER III

##### TESTS OF RENAL FUNCTION

Tests of excretion	46
Tests of retention	52
Combined tests of excretion and retention	62

#### CHAPTER IV

##### INSTRUMENTAL EXAMINATION

Urethral exploration (with bougies sounds and filiforms)	71
Urethral catheterization	74
Ureteral catheterization	83
Urethroscopy	87
Cystoscopy (with examination of the upper tract)	104
Cystoscopy and urethroscopy in children	122

#### CHAPTER V

##### ROENTGENOGRAPHY OF THE GENITO-URINARY TRACT

Plain roentgenograms	125
Retrograde pyelo-ureterography	129
Serial pyelography	133
Intravenous pyelo-ureterography (excretory urography)	138
Subcutaneous urography	141
Peroral urography	142

Interpretation of pyelo-ureterograms	143
Renal arteriography	171
Pneumoperitoneum	171
Excretion urography as a measure of residual urine	171
Cystography and urethrography	172
Seminal vesiculography	185

## CHAPTER VI

## ANESTHESIA IN UROLOGY

Preparation of patient preliminary medication	191
General inhalation anesthesia	192
Rectal anesthesia (with avertin)	197
Regional anesthesia	198
Local infiltration anesthesia	212
<i>Local anesthesia for intraurethral procedures</i>	213
Intravenous anesthesia	215
Summary of anesthetic practice in authors' clinic	217

## CHAPTER VII

## EMBRYOLOGY, ANATOMY, ANOMALIES, AND PHYSIOLOGY OF THE PENIS

Embryology of the penis	223
Anatomy of the penis	226
Anomalies of the penis	229
Physiology of the penis	241

## CHAPTER VIII

## INJURIES AND DISEASES OF THE PENIS

<i>Injuries of the penis</i>	245
Diseases of the penis	252

## CHAPTER IX

## OPERATIVE TREATMENT OF THE PENIS

Anesthesia	318
Preparation of operative field	318
Circumcision	319
Surgical treatment of penile carcinoma	323
<i>Plastic surgery of the penis</i>	334

## CHAPTER X

## EMBRYOLOGY, ANATOMY, ANOMALIES, AND PHYSIOLOGY OF THE SCROTUM AND SCROTAL CONTENTS

Embryology	360
Anatomy	365
Anomalies	375
Physiology	384

## CHAPTER XI

## INJURIES AND DISEASES OF THE SCROTUM AND THE SCROTAL CONTENTS

Injuries of the scrotum and scrotal contents.....	400
Diseases of the scrotum and scrotal contents.....	414

## CHAPTER XII

## OPERATIVE AND NON-OPERATIVE TREATMENT OF THE SCROTUM AND SCROTAL CONTENTS

Operative treatment of the scrotum and scrotal contents.....	486
Non-operative treatment of the scrotum and scrotal contents.....	517

## CHAPTER XIII

## EMBRYOLOGY, ANATOMY, ANOMALIES, AND PHYSIOLOGY OF THE VAS DEFERENS, SEMINAL VESICLE, AND EJACULATORY DUCT

Embryology. ....	521
Anatomy.....	522
Anomalies of the vas deferens, seminal vesicle, and ejaculatory duct.....	526
Physiology. ....	526

## CHAPTER XIV

## INJURIES AND DISEASES OF THE VAS DEFERENS, SEMINAL VESICLE, AND EJACULATORY DUCT

Injuries of the vas deferens, seminal vesicle, and ejaculatory duct.....	529
Diseases of the vas deferens, seminal vesicle, and ejaculatory duct.....	529

## CHAPTER XV

## OPERATIVE AND NON-OPERATIVE TREATMENT OF THE VAS DEFERENS, SEMINAL VESICLE, AND EJACULATORY DUCT

Operative treatment.....	556
Non-operative treatment of the vas deferens, seminal vesicle, and ejaculatory duct.....	562

## CHAPTER XVI

## EMBRYOLOGY, ANATOMY, ANOMALIES, AND PHYSIOLOGY OF THE FEMALE EXTERNAL GENITALIA

Embryology of the female external genitalia.....	569
Anatomy of the female external genitalia... ..	571
Anomalies of the female external genitalia.. ..	576
Physiology of the female external genitalia. ....	580

## CHAPTER XVII

## INJURIES AND DISEASES OF THE FEMALE EXTERNAL GENITALIA

Injuries of the female external genitalia.....	581
Diseases of the female external genitalia.....	581

## CHAPTER XVIII

## OPERATIVE TREATMENT OF THE FEMALE EXTERNAL GENITALIA

Preoperative preparation.....	602
Anesthesia.....	602



Circumcision	603
Clitoridectomy	603
Extirpation of Bartholin's glands	603
Vulvectomy	603
Operative treatment of hypospadias in the female	603
Operative treatment of epispadias in the female	603
Postoperative care	605

## CHAPTER XIX

## EMBRYOLOGY, ANATOMY, ANOMALIES, AND PHYSIOLOGY OF THE MALE URETHRA

Embryology of the male urethra	607
Anatomy of the male urethra	610
Anomalies of the male urethra	615
Physiology of the male urethra	629

## CHAPTER XX

## INJURIES AND DISEASES OF THE MALE URETHRA

Injuries of the male urethra	632
Diseases of the male urethra	637

## CHAPTER XXI

## OPERATIVE TREATMENT OF THE MALE URETHRA

Preoperative preparation	672
Position of patient on operating table	672
Anesthesia	672
Operative treatment of stricture of the urethra	673
Operative treatment of ruptured urethra	679
Operative treatment of congenital valves of the posterior urethra	685
Excision of urethral diverticulum	691
Excision of urethroperineal fistula	693
Operative treatment of recto-urethral fistula	694
Excision of accessory channel	696
Operative treatment of urethral calculus	696
Repair of hypospadias and epispadias	699
Postoperative considerations in urethral surgery	699

## CHAPTER XXII

## GONORRHEA IN THE MALE

Introduction	701
History	702
Public health and epidemiological aspects	703
Definition	705
Bacteriology	705
Predisposing factors	708
Modes of transmission	708
Pathology	708

## CONTENTS

xv

Symptoms	712
Diagnosis	715
Treatment	717
Criteria of cure	726

### CHAPTER XXIII

#### COWPER'S GLANDS

Embryology of Cowper's glands	732
Anatomy of Cowper's glands	734
Anomalies of Cowper's glands	736
Physiology of Cowper's glands	736
Injuries of Cowper's glands	736
Diseases of Cowper's glands	737
Operative treatment of Cowper's glands	743

### CHAPTER XXIV

#### EMBRYOLOGY, ANATOMY, ANOMALIES AND PHYSIOLOGY OF THE FEMALE URETHRA

Embryology of the female urethra	748
Anatomy of the female urethra	749
Anomalies of the female urethra	751
Physiology of the female urethra	753

### CHAPTER XXV

#### INJURIES AND DISEASES OF THE FEMALE URETHRA

Injuries of the female urethra	756
Diseases of the female urethra	757

### CHAPTER XXVI

#### OPERATIVE TREATMENT OF THE FEMALE URETHRA

Preoperative preparation	781
Anesthesia	781
<i>Diversion of the urinary stream</i>	781
Operative treatment of Skene's glands	782
Operative treatment of prolapse of the urethra	783
<i>Operative repair of urethrovaginal fistula</i>	784
Postoperative considerations following operations on the female urethra	785

### CHAPTER XXVII

#### EMBRYOLOGY, ANATOMY, ANOMALIES AND PHYSIOLOGY OF THE PROSTATE GLAND

Embryology of the prostate gland	787
Anatomy of the prostate gland	792
Anomalies of the prostate gland	800
Physiology of the prostate gland	801

## CHAPTER XXVIII

## INJURIES AND DISEASES OF THE PROSTATE GLAND

Injuries of the prostate gland	804
Diseases of the prostate gland	806

## CHAPTER XXIX

## OPERATIVE AND NON-OPERATIVE TREATMENT OF THE PROSTATE GLAND

Operative treatment of the prostate gland	878
Non-operative treatment of the prostate gland	935

INDEX	i
-------	---

## VOLUME II

## CHAPTER XXX

## EMBRYOLOGY ANATOMY ANOMALIES AND PHYSIOLOGY OF THE BLADDER

Embryology of the bladder	943
Anatomy of the bladder	946
Anomalies of the bladder	957
Physiology of the bladder	968

## CHAPTER XXXI

## INJURIES AND DISEASES OF THE BLADDER

Injuries to the bladder	986
Diseases of the bladder	994

## CHAPTER XXXII

## OPERATIVE AND NON-OPERATIVE TREATMENT OF THE BLADDER

Operative treatment of the bladder	1102
Non-operative treatment of the bladder	1158

## CHAPTER XXXIII

## EMBRYOLOGY ANATOMY ANOMALIES AND PHYSIOLOGY OF THE URETER

Embryology of the ureter	1208
Anatomy of the ureter	1210
Anomalies of the ureter	1213
Physiology of the ureter	1226

## CHAPTER XXXIV

## INJURIES AND DISEASES OF THE URETER

Injuries to the ureter	1232
Diseases of the ureter	1239

## CHAPTER XXXV

## OPERATIVE TREATMENT OF THE URETER

Preoperative preparation	1302
Preparation of the operative field	1302
Anesthesia	1302

Surgical treatment of ureteral anomalies	1302
Surgical treatment of stenosis of the ureterovesical orifice	1304
Surgical treatment of non-calculous obstructions at the ureteropelvic junction	1305
Operative treatment of ureteral injuries	1315
Operative treatment of ureteral calculus	1320
Ureterectomy	1324
Uretero-intestinal anastomosis.	1324

## CHAPTER XXXVI

## EMBRYOLOGY, ANATOMY, ANOMALIES, AND PHYSIOLOGY OF THE KIDNEY

<i>Embryology of the kidney</i>	1343
<i>Anatomy of the kidney</i>	1350
<i>Anomalies of the kidney</i>	1361
<i>Physiology of the kidney</i>	1384

## CHAPTER XXXVII

## INJURIES AND DISEASES OF THE KIDNEY

Injuries of the kidney and renal pelvis	1395
Diseases of the kidney and renal pelvis	1405

## CHAPTER XXXVIII

## OPERATIVE AND NON-OPERATIVE TREATMENT OF THE KIDNEY

Operative treatment of the kidney	1655
Non-operative treatment of the kidney	1715

## CHAPTER XXXIX

## RADIUM AND ROENTGEN-RAY THERAPY OF THE GENITO-URINARY TRACT

Introduction	1724
Carcinoma of the penis	1734
<i>Epithelioma of the scrotum</i>	1736
Tumors of the testicle	1736
Malignant tumors of the seminal vesicle and spermatic cord	1739
<i>Malignant tumors of the female external genitalia</i>	1739
Malignant tumors of the male urethra	1742
Malignant tumors of Cowper's glands	1743
<i>Malignant tumors of the female urethra</i>	1744
Radiation treatment of benign hypertrophy of the prostate gland	1745
Carcinoma of the prostate gland	1747
<i>Tumors of the bladder</i>	1750
Tumors of the kidney and ureter	1758

## CHAPTER XL

## DRIED HUMAN BLOOD PLASMA THERAPY

Preparation and packaging of dried plasma	1766
Advantages of plasma over whole blood	1767
Dangers of plasma administration	1768

## CHAPTER I

### HISTORY-TAKING AND PHYSICAL EXAMINATION

#### A HISTORY-TAKING

History taking is the first step in examination. A urological history does not differ from any other complete clinical record except for the emphasis of those features pertaining to the urogenital tract.

First, let the patient relate his story in his own words, interrupting only enough to clarify such points as appear to have an important bearing upon the condition. When the tale is finished, the history may be recapitulated and all information obtained from the patient (or his relatives) jotted down systematically so as to provide, with the findings of examination, a useful record for future reference. The complete record should include (1) nature of the complaint, (2) present illness, (3) family history, (4) personal history (past and present), (5) resumé of patient's present condition, (6) general physical examination, (7) special examination of the urogenital tract, (8) charts helpful in examination of the urogenital tract.

#### *Nature of the Complaint*

The first item of the history should always be the complaint of the patient in his own words. The information should be elicited by questions which are not leading and recorded exactly as stated by the patient. If, for example, he says, "I have a pain in my back," this should be so entered in the history—not "The patient complains of discomfort in the lumbar region."

#### *Present Illness*

After the patient's own statement of his complaint, there should be set down all the essential data relating to the condition for which he has sought advice.

**Duration** It is advisable to inquire the date when the patient last felt well, for while this is seldom forthcoming in exact terms, it will serve to set a limit to his recollections and help in determining the duration of his illness.

**Variation in Weight** Of importance is any variation in weight The normal weight and deviations from it should therefore be noted

**Pain** As pain is usually the immediate reason for seeking medical advice, it is seldom difficult to obtain a somewhat detailed account of its manifestations One should jot down the statements made in regard to its location, the direction in which it radiates, its character ( "throbbing," "knife like," "grinding "), its intensity, and duration (whether intermittent or continuous) Special types of pain are characteristic of particular diseases and organs For example, the pain of tenesmus or stranguary, felt in the bladder at the end of micturition, is due to inflammation of the bladder neck, chordee or painful penile erection is usually related to inflammation of the corpus spongiosum, and a "dragging pain" in the groin immediately suggests involvement of the cord or vesicles or the undue weight of a swollen testicle

*Pain in the kidney and ureteral regions* has especial diagnostic value The examiner should find out whether the painful sensations are referred to the back to one side underneath the free border of the ribs or to the ilio-costal space in front Pain in the ureter is frequently reflected, either toward the bladder and testicle below or to the kidney above If there is present a calculus or a sufficient degree of renal ptosis to permit twisting of the pedicle of the kidney (Dietl's crisis) the pain will usually have a definite point of maximum intensity which the patient will be able to indicate Pain due to abnormal conditions of the kidneys and ureters is likely to occur in zones In the kidney region the painful area will often be triangular, with the base of the triangle posteriorly between the inferior margin of the ribs the spinal column, and the pelvis, and the apex anteriorly below the free margin of the ribs If the pain actually originates in the kidney, the patient will usually locate it in some part of this triangle and bimanual palpation generally elicits a corresponding area of tenderness

*Pain in the groin* may have important diagnostic significance For example, in epididymitis extension of the inflammation from the urethra along the vas deferens causes pain in the groin before attention is called to the epididymis itself A dull ache in the groin may be due to an inflamed vesicle, pressure on the ejaculatory ducts hypertrophy of the prostate, or prostatitis

*Suprapubic pain* of an indefinite nature, or a sense of fulness in the suprapubic region, is most likely to be due to retention of urine If the

retention is sudden and acute, however, the patient will complain of "cramps." Inflammation of the bladder also produces suprapubic pain, especially if due to a tuberculous process or the presence of a stone.

**Urination** The character of the urination is, of course, significant. Frequency and difficulty in voiding are the complaints most commonly heard. The details of this important phase of examination will be considered farther on.

### *Family History*

The family history is next taken up, and inquiry made concerning the immediate relations: (1) their ages and states of health, if living, or their ages at death and the causes of death, (2) the occurrence of any congenital abnormality, especially if it has shown a hereditary tendency (undescended testicle, hypospadias, polycystic kidneys, etc.), (3) the occurrence of malignancy, kidney disease, and infectious diseases, such as tuberculosis, (4) any history of nervous or mental affections.

Influenced by hereditary tendencies are many diseases of special interest to the urologist: arteriosclerosis, diabetes, and nephritis, as well as certain lesions of the brain and spinal cord and special manifestations of hysteria and neurasthenia which are closely related to diseases of the urogenital tract. Derangements of the nervous system acquire particular significance when the close relationship between the mechanism of the urinary tract and the nervous system is borne in mind. Lesions of the latter may occasion functional disturbance of the kidneys, bladder, prostate, urethra, or any one of the generative organs, and it is well established that nerve derangements may be the direct cause of organic changes in the kidneys.

The family history is of importance also because of the likelihood of contagion induced by the close associations of a single household. If a member of the patient's immediate family is afflicted with tuberculosis, it will at once place the examiner upon his guard. Should he detect evidence of a chronic process in the urogenital tract for which there seems to be no immediate explanation, and even if the physical examination of the lungs has been negative, this bit of familial history may enable him to determine the existence of a tuberculous vesiculitis or tuberculous infection of some other part of the urogenital tract.

Familial tendency to malignancy is still a moot question, but no examiner, whatever his personal opinion, will lose anything by giving care

ful consideration to the possibility of malignant disease in a patient who complains of symptoms referable to the prostate, bladder, or kidney while supplying a history of malignancy of any kind in his immediate family.

### *Personal History*

In the case of a young child the personal history may sometimes be carried back to the intrauterine period, but in most instances the examiner can expect to obtain only such information as is stored up in the patient's memory

**Age** The age of the patient is naturally of great importance. Each period of life has its peculiar disturbances of the urinary and sexual apparatus. In infants and young children, especially little girls, pyelitis is quite frequently encountered, and congenital anomalies, such as a tight prepuce, urethral stricture, or valves of the posterior urethra, may produce serious disturbance of the urinary function. In older children one must be on the look-out for lesions due to infection with the gonococcus, especially in little girls, whose delicate vaginal mucosa makes them particularly liable to inflammatory activity by this organism. Tuberculosis of the urogenital tract, urinary stone, and renal tumors (Wilms' embryoma) are other not uncommon conditions in children.

At puberty, and following adolescence, the incidence of tuberculosis greatly increases. Active gonococcal infection is seen less frequently after the third decade, but its later results are often manifest diseases of the vesicles and prostate in men, diseases of the tubes and ovaries in women, and, in both sexes, urethral stricture and cystitis. As age advances, the chances of encountering tuberculosis decrease but the incidence of malignancy becomes greater, and kidney and bladder lesions are common. Stricture of the urethra is also often seen. Lesions of the nervous system, especially those due to syphilis, contribute largely to swell the number of the middle aged genito urinary patients.

In later life, malignancy and lithiasis become increasingly common, and hypertrophy of the prostate compels many to seek the urologist's aid.

**Diseases of Childhood** The diseases of childhood should be listed and their possible part in the etiology of the patient's present complaint carefully weighed.

Nephritis is a common sequel of scarlet fever and diphtheria and, less often of variola, measles, meningitis, typhoid fever, and influenza. Any



severe disease, such as pneumonia or acute enteritis, may irritate the kidney to the point of inflammation in its attempt to eliminate noxious products. Kidney lesions may also be started by the toxins generated by infectious organisms, or they may be caused by the direct action of bacteria. Acute infections, such as boils, otitis media, tonsillitis, sinusitis, etc., especially when due to staphylococci, are often followed by secondary infections of the kidney.

Orchitis is a fairly common complication of mumps in boys and young men, and may also accompany typhoid fever, tonsillitis, influenza, small pox, and arthritis. The orchitis of mumps is most common about the time of puberty, being almost unknown in childhood and observed in about 5 per cent of cases of mumps in young adults.

In only a few of the many cases of kidney stone seen by urologists is it possible to find the original cause of the stone formation, but it is our impression that such concretions form only when there is a pathological groundwork in the form of necrotic or damaged kidney tissue upon which salts are deposited, and that in many cases the infectious diseases of childhood are undoubtedly responsible for this pathological basis.

**Other Antecedent Infections** It is hardly necessary to emphasize the importance of eliciting a history of *all* antecedent infections. In urology, more perhaps than in any other medical specialty, the manifest lesions often have origins remote both in time and bodily location. Our increasing knowledge of focal infection is constantly opening up new etiological avenues. The mention of "rheumatism" now suggests the possibility of a gonorrheal arthritis, and the causal factor of many kidney and bladder affections has been traced to the site of persistent attacks of tonsillitis.

Of the importance of a history of antecedent venereal disease there should be little need to speak, yet the remote effects of these infections, especially gonorrhea, are often left out of account. Many a sterile woman has been subjected to repeated gynecological exploration or operation in the vain endeavor to satisfy a desire for offspring, when all the while the sterility was due to an acute bilateral epididymitis resulting from a forgotten attack of gonorrhea suffered long before by her "perfectly healthy" husband. Similarly, a negative Wassermann reaction does not always insure either patient or physician from having to deal with the remote sequelae of syphilis. The examiner who has been given a history of venereal disease must keep it constantly in mind throughout

the examination and must weigh it carefully against every other factor elicited in the attempt to establish a diagnosis

**Previous Operations and Instrumentation.** It is important to ascertain if the patient has ever had any operation or instrumentation, and if so, what, when, by whom performed, and the result

**Headache** A history of persistent headache should always arouse the interest of the examiner. The headache of nephritis, excepting the sudden attack due to uremia, is usually caused by the arteriosclerosis which is so often an essential part of chronic nephritis. Headache due to chronic nephritis is apt to be throbbing in character, shifting from one spot to another, and accompanied by vertigo and tinnitus. While frontal headache is most often due to a pathological condition of the sinuses, it is not infrequently a manifestation of a renal lesion or chronic infection of the prostate or seminal vesicles.

**Disturbances of Urination** Detailed inquiry should be made into the urinary history of every patient who presents himself for examination. It is extremely important to learn if there has ever been any change in the urinary habits. The patient should therefore be questioned regarding pollakiuria (abnormal frequency), difficulty of urination, urgency (inability to retain the urine after desire for evacuation of the bladder is felt), dysuria (pain or burning on urination), nocturia (the necessity of rising at night to urinate), incontinence, polyuria (the excessive secretion and discharge of urine, that is, more than 2,500 cc a day), oliguria (scanty excretion of urine), and anuria (absence of urine).

*Frequency of urination* may be due to (1) an increase in the amount of urine as a result of (a) disease (diabetes mellitus, diabetes insipidus, nephritis) or (b) the ingestion of increased amounts of fluid, (2) psychic factors, (3) lesions of the brain or spinal cord, (4) local irritation by abnormal substances excreted in the urine, (5) overstimulation of vesical contraction due to irritation resulting from infections of the bladder, prostate, or urethra, (6) diminution in the amounts voided on account of vesical or urethral obstruction.

*Difficulty of urination* is usually associated with some form of obstruction in the urethra or bladder neck. Difficulty is one of the earliest symptoms of tabes dorsalis, retention followed by incontinence coming on later.

*Dysuria* is associated, as a rule, with some inflammatory condition of the bladder, vesical neck, or urethra.

*Incontinence* may be complete or partial and is due to relaxation or

weakening of the sphincters as a result of (1) trauma, (2) inflammation, (3) retention due to obstruction or to paralysis of the detrusor

*Polyuria* occurs during the absorption of large serous effusions and in many nervous conditions, also in chronic interstitial nephritis, diabetes insipidus, and diabetes mellitus

*Oliguria* and *anuria* are of much greater significance to the urologist than polyuria. Either may be caused by (1) mechanical obstruction, either within the kidney or in the ureter or lower tract, (2) diminished fluid intake, (3) dehydration, (4) renal insufficiency due to nephrosis or glomerulonephritis, (5) hysteria, (6) circulatory disturbances and other factors. Hemoglobinuria anuria is a form of anuria due to transfusion of blood, presumably of the wrong type, causing rapid disintegration of hemoglobin (hemoglobinolysis) and obstruction of the renal tubules by hemoglobin crystals

The patient should be interrogated regarding alteration in the urinary stream especially diminution of its usual size and force. Such change is usually indicative of some obstruction at the bladder neck or in the urethra

Inquiry should also be made regarding marked variations from the normal in the appearance of the urine

**Hematuria** It is most important to ascertain whether hematuria has been observed at any time. Blood in the urine is a most important symptom, and, fortunately, usually frightens the patient enough to make him seek medical advice without delay. Although hematuria may be due to systemic or other extra urinary tract causes, in the vast majority of cases there is a lesion of some kind in the urogenital tract. In a very high percentage of vesical and renal tumors bloody urine is a cardinal symptom. In well over 50 per cent of all cases of hematuria the blood is produced by a urinary tract tumor—usually malignant, hence the obvious importance of determining without delay the source and cause of blood in the urine. After tumor, calculus and tuberculosis are the most frequent inciting causes. Inflammatory conditions of the urinary tract are the most common causes of hematuria in women, vesical papilloma and carcinoma in men. In both sexes inflammatory conditions and stone have been found to be the most frequent causes in the first four decades of life, neoplastic conditions beginning to be common during the fifth decade. Hematuria in infancy and childhood is infrequent

The following table lists the urogenital and extra urogenital causes of hematuria

*Causes of Hematuria*

## I Systemic Diseases

- a. Renal infarction in endocarditis
- b. Arteriosclerosis
- c. Leukemia and other blood dyscrasias
- d. Purpura
- e. Hypertension with nephritis
- f. Hodgkin's disease
- g. Scurvy
- h. Hemophilia
- i. Acute fevers

## II Urinary Tract Affections

## 1 Renal

- a. Malignant or benign tumors
- b. Traumatic injury
- c. Calculus
- d. Tuberculosis
- e. Acute pyelonephritis
- f. Pyelitis cystica
- g. Hydronephrosis
- h. Polycystic disease
- i. Oxaluria
- j. Nephritis (acute and subacute)
- k. Bacilluria and bacteriuria
- l. Drugs turpentine carbolic acid cantharides urotropine, hexamine, sodium salicylate etc.

## 2 Ureteral

- a. Calculus
- b. Uretentis cystica
- c. Malignant or benign tumors
- d. Stricture

## 3 Vesical and Prostatic

- a. Papilloma or carcinoma of the bladder
- b. Bilharziasis
- c. Prostatic hypertrophy or carcinoma
- d. Tuberculosis of the bladder or prostate
- e. Calculus or foreign body
- f. Acute cystitis
- g. Trauma
- h. Acute spermato-cystitis

## 4 Urethral

- a. Acute urethritis
- b. Impacted calculus
- c. Trauma
- d. Papilloma nevus
- e. Stricture

## III Disease of Neighboring Organs Involving Urinary System

- a. Carcinoma of uterus vagina rectum
- b. Acute appendicitis
- c. Acute salpingitis
- d. Pelvic abscess
- e. Dysenteric or tuberculous ulceration of intestine
- f. Diverticulitis

Some idea regarding the source of the blood in the urine may be gained from its color. The longer the blood has been in the urine, the more discolored it will appear. The higher up in the urinary tract its source, the more likely it is to be well mixed with the urine. In highly acid urine the blood assumes a brownish cast, in an alkaline urine it is a brighter red. If pus is also present, and obstruction has held back the urine until decomposition has begun, it will have a dark brown or even blackish appearance and a foul odor. Brownish or smoky urine indicates, in general, that the quantity of blood is small, that it has had time to become well mixed with the urine, and that the reaction is acid. The blood is, therefore, most likely to have come from the kidney. In renal hematuria the sediment forms only after several hours of standing, the blood precipitating very slowly. Bright red blood, not mixed with the urine, means free bleeding from an arterial source, this may be in any part of the urinary tract, though disease of the bladder or prostate is most likely to be responsible.

The origin of the hematuria may also be suggested by the character of the bleeding. Hemorrhage from the urethra usually consists of unaltered blood, escaping drop by drop or in a continuous stream. Blood from the prostate gland may pass into the urethra and be voided during the first part of the urinary act. Hemorrhage from the bladder usually gives no sign at the commencement of the act, but as urination continues, the blood becomes more evident until, at the end, the stream may consist of almost pure blood. When bladder tumor is present the bleeding is usually continuous, with no intervals of cessation as in other lesions. In lesions of the vesical neck there is likely to be bleeding at both the beginning and end of the act. The blood which comes out first has accumulated in the deep urethra since the last micturition, and contraction of the bladder at the close of micturition causes fresh hemorrhage, which is immediately voided—hence the brighter color of the blood at the end of the act.

Renal hemorrhage is manifested by dark smoky urine, and never resembles pure blood unless it has escaped abundantly and rapidly from the renal pelvis as may be the case in trauma. Recurrent attacks of hematuria without symptoms of bladder irritation, are generally referable to the kidney. Sometimes blood from the kidney will coagulate in the ureter, forming worm like clots. During the formation of the clots, hemorrhage will cease, but usually it recommences with renewed energy immediately the clot is passed.

*Hemoglobinuria*—the presence of dissolved hemoglobin in the urine—also gives the urine a bloody appearance. It is likely to be observed after acute infections, such as typhoid or malarial fever, in certain blood dyscrasias, such as purpura or scurvy, and in Raynaud's disease. It is due to disintegration of the blood elements and occurs when large hemorrhagic effusions have been absorbed without drainage or when the blood elements are destroyed by disease.

Excessive amounts of such drugs as trional and sulphonal cause *hematoporphyrinuria*, and are sometimes the cause of the so-called "essential hematuria." In two of Lowsley's cases hematuria followed the ingestion of salol by the patients for the treatment of colds. After complete cystoscopic and pyelographic examination the condition cleared up. Both patients again took salol when they had a second cold, with recurrence of the hematuria in both instances. Upon withdrawal of the drug the hematuria cleared up. Since then other drugs have been taken for colds by these patients, with no recurrence of the hematuria.

**Marital and Sexual History** The marital history is often suggestive. One should ascertain the length of the marital life, the state of health of wife or husband, whether or not there are children and if so, their number and physical condition. A history of miscarriages is always significant, whether the man or the woman be under examination.

Sexual symptoms may form the chief complaint for relief of which the patient consults a urologist, or they may complicate a urogenital condition. The symptoms refer, as a rule, to disturbances of desire, erection, and ejaculation, and changes, or fancied changes, in the appearance of the external genitalia. Some of these cases have an organic and others a psychoneurotic origin, and it is important that the responsible factors be determined before treatment is attempted. A careful analysis of the sexual habits and symptoms is also essential for successful treatment of sterility, for the correction of which the urologist is often consulted.

In order to deal with any patient successfully, the physician must gain his confidence and regard. The family relations and home atmosphere often have a strong bearing upon the occurrence of genito-urinary affections. The examiner who can make the patient look upon him as a friend to whom he feels free to reveal his private woes and discouragements may elicit much pertinent information in this way. The higher up in the social and intellectual scale the patient, the greater, as a rule, will be his reticence, but patience, tact, and casual frankness will usually serve to break down barriers.

**Environment and Occupation** Environment and occupation have an important relation to urological conditions. A change of occupation will often account for otherwise inexplicable physical conditions. An altered financial status also may react upon the bodily health. It is well known to life insurance examiners that a man who has suddenly risen from comparative poverty to affluence, and thereupon applies for a policy, is a poorer risk than a man of the same age and physical state whose outward circumstances have not undergone so sudden an alteration. The moral hazard is far greater, and many physical ills, which never attended a man when he walked to his daily job, may overwhelm him when he becomes able to motor to business with a hired chauffeur.

**Habits** The habits of an individual have a marked influence upon any existing pathological condition, and should be the subject of careful inquiry. It is not enough to ascertain his attitude toward the use of alcohol and tobacco, these are important, but the materials which go to make up his three meals a day are equally, if not more so. If he habitually gets less sleep than his system requires, this fact may serve to explain an otherwise perplexing lack of general resistance.

Inquiry should be made concerning the hours of work and of recreation, the amount and kind of food taken and the usual state of the appetite, the use of alcohol, tobacco, and other drugs, the time allotted for sleeping, and the amount of water drunk.

### *Résumé of Patient's Present Condition*

Having informed himself concerning the patient's general health and specific urological condition, the examiner should now take up his chief complaint and make particular inquiry into (1) the probable cause of the trouble, (2) its duration, (3) the course up to the present time, (4) any previous treatment, (5) minute details of the present symptoms.

If time is limited, the patient may be restricted to giving categorical answers, following which it is customary to invite him to add to the facts obtained if, at the end of the examination, he thinks that anything of importance has been omitted.

## **B PHYSICAL EXAMINATION**

### *General Physical Examination*

When the history has been completed, a general physical examination should be made. A careful general examination is the logical primary step in the handling of any urological or other medical problem. Such an

examination having been made, the examiner can then direct his attention more specifically to the urogenital tract. Invaluable as are the many newer diagnostic facilities available to the urologist—the products of the laboratory and instrument maker—these, obviously, should supplement and not supplant the basic physical investigation.

The alert physician will already have noticed the patient's general attitude, that is, whether he appears nervous, worried, morose, or in any way uncomfortable, either physically or mentally. The condition and color of the patient's skin are in many cases of diagnostic significance. For example, a yellow skin, taken in conjunction with a cachectic looking body and a prostate suspiciously hard but not unquestionably malignant, will add great weight to the probability of malignancy.

The general examination should include inspection of the head, eyes, ears, mouth, tongue, gums, teeth, nose, pharynx, larynx, and neck, palpation of the abdomen, tests of all reflexes, determination of the blood pressure, and a complete urinalysis. Ascertaining the condition of the circulation, the lungs, and the digestive tract is especially important.

### *Special Examination of the Urogenital Tract*

**Extent of the Examination** Physical examination of the urogenital tract should include inspection and palpation of the penis, testicles, and epididymes, and palpation of the kidneys, suprapubic region, prostate, seminal vesicles, and urethra. The most convenient order of examination is as follows: (1) inspection of the external genitals; (2) palpation of the kidneys and ureters; (3) palpation and percussion of the bladder; (4) rectal palpation of the prostate, seminal vesicles, and other structures palpable by this route; (5) palpation of the penis, urethra, and scrotal contents.

*Inspection* will often give an immediate clue by revealing an enlargement, not alone of the external genitals but often also of some internal structure that has increased in size to such an extent as to be visible upon the surface. For instance, periurethral swelling and follicular abscess may cause sufficient enlargement along the course of the urethra to be observable with the unaided eye. Externally visible edema, due to inflammation and extravasation of urine, is not uncommon in the same location. An overdistended bladder may appear as a tumor extending upward as far as the umbilicus.

Inspection of the renal region is not likely to be of diagnostic value



unless enlargement of the kidneys is very marked. However, in acute inflammatory renal affections, even when enlargement is not perceivable, it is sometimes possible to distinguish a difference in the mobility of the two organs.

*Palpation* is a valuable means of detecting the presence of disease in the kidneys, prostate, seminal vesicles, testicles, and epididymes, while *percussion* is useful in supplying information concerning the location of a possible abdominal tumor. The combination of palpation with percussion may give information regarding the presence or absence of tumors of the kidney or neighboring organs.

**Inspection of External Genitals** The size and shape of the organs will naturally be the first matter to engage the examiner's attention. Even a cursory inspection will reveal the existence of such marked anomalies as hypospadias and pseudohermaphroditism, but more careful search will be necessary to determine the condition of the prepuce, the existence of phimosis or partial atresia, and the presence of lesions such as ulcers, abscesses, nodules, and enlarged glands. The meatus should be thoroughly examined, and its size, shape, and general appearance noted. Congenital strictures of the urethra are quite common, and are usually found either at the meatus or near the outer end of the fossa navicularis.

If the meatus shows induration, with the lips pressed together, a syphilitic infection should immediately be suspected even if, as is often the case, no history of venereal disease has been elicited. Similarly, ulceration at the meatus is suggestive of chancroid. The presence of a discharge is usually diagnostically significant, and a smear should be obtained for microscopic examination.

**Palpation of the Kidneys** Palpation of the kidney should be undertaken with the patient on his back, the knees flexed, and the shoulders elevated, so that the abdominal muscles will be thoroughly relaxed. It is best performed with two hands. One of the examiner's hands is placed beneath the patient's back and presses upward upon the costo-vertebral angle while the other presses toward it from in front on the abdomen, under the costal margin. The patient is directed to breathe deeply, with quick expirations, the examiner pressing firmly downward as the abdominal wall relaxes on expiration. The kidney, or its lower pole, can usually be felt between the two hands. Turning the patient upon the side opposite to the one being palpated, and having him lie with the knees well drawn up and the body slightly bent, will sometimes enable one to feel an otherwise impalpable kidney.

Bimanual palpation is useful in detecting renal enlargement, mobility, and tenderness. Light palpation in the kidney region will often enable the examiner to detect muscular contractions or spasms induced by acute infection. Muscular rigidity of the entire affected side is not infrequently revealed by palpation. When such rigidity is in the region of the quadratus lumborum muscle, it may indicate a renal lesion which previous, more general palpation has failed to reveal. Acute inflammation of the kidney produces lumbar tenderness, which sometimes extends over the entire lumbar region but more often is confined to the costovertebral space and the region of the tenth, eleventh, and twelfth ribs.

When the kidney is enlarged it usually forms a movable tumor of ovoid form, partially hidden from both inspection and palpation by the over arching ribs. The elicitation of tenderness is a likely indication of inflammation, and the diffusion of a perirenal exudate is so characteristic as to be immediately apparent to an experienced examiner. It may be difficult or impossible, however, by palpation alone to distinguish an enlarged kidney from an adrenal or retroperitoneal growth, and the procedure may reveal little more than a mass in the loin which *may* be of renal origin. If there is great enlargement of the kidney, the mass may readily be confused with a tumor arising in the pancreas, gall bladder, or even in the liver. The kidney, however, lies farther to the side than any of these organs, with the exception of the right border of the liver, and can therefore usually be distinguished by lumboabdominal palpation.

*Renal Ballottement* The foregoing technic may sometimes fail to render the kidney palpable, but by tapping the lumbar wall sharply with the left hand it may be possible to elicit renal ballottement. This is a sensation somewhat akin to fetal ballottement, and is imparted to the fingers of the palpating right hand when the sudden sharp pressure inward of the left fingers causes a mass within the abdominal cavity to come in contact with them. This may first be attempted during normal respiration, the patient is then told to breathe deeply, and the maneuver is repeated as respiration ends and the abdominal wall relaxes.

Ballottement is useful in revealing slight enlargements, mobility, and tenderness, but if the kidney is found to be freely movable or markedly enlarged, it can best be examined by bimanual palpation. With one hand upon the back and the other upon the abdomen, the kidney can usually be readily outlined, and its size and shape, as well as its range of motion, determined by palpation and percussion.

**Palpation of the Ureters** A normal ureter cannot be felt through the abdominal wall, but, if inflammation exists, palpation through the abdominal parietes may elicit points of tenderness along its course. Tenderness in this region may be due to other causes, however, and, if taken alone may lead to an erroneous diagnosis. Many an innocent gall bladder or appendix has been sacrificed because of the pain caused by an inflamed ureter.

In the female, the pelvic portion of the ureter may be palpated at the point where it runs transversely across the anterior vaginal cul de sac, but elsewhere it is impalpable unless greatly enlarged. In the male, some information regarding the condition of the ureter may be obtained by palpation upon the anterior wall of the rectum. If a stone has lodged at the ureteral entrance to the bladder, beyond the seminal vesicle, it may be palpated through the rectal wall.

**Palpation and Percussion of the Bladder** A certain amount of information concerning the bladder may be gained by palpation and percussion. The examiner will be able to palpate the bladder only when it is distended at least half way to the umbilicus. Suprapubic percussion of the distended bladder will produce a dull note, the extent of the area of dulness being proportional to the degree of distention.

**Rectal Palpation** Rectal palpation is of great importance to any thorough diagnostician, but particularly so to the urologist.

The examining finger (usually the index finger of the right hand) should be protected by a rubber glove or a rubber finger cot combined with a rubber shield. The finger should be well lubricated.

**Position of Patient** The best position is the exaggerated knee chest position, with the patient kneeling upon the table. Simpler, but less satisfactory, is the standing elbow knee position with the body bent over and supported by the elbows on the knees, feet apart and legs slightly flexed, or the patient may lean over a table, equipped with a heavy pad or sand bag, his feet placed pigeon toed and the legs slightly flexed. The muscles should be as relaxed as possible.

The recumbent position may occasionally be necessary but is much less satisfactory. The patient may lie upon his back with the thighs well separated and the buttocks slightly elevated by small sand bags or cushions, or, preferably, he may lie well over on the left side, with the right knee and thigh drawn up so as to expose the perineum as fully as possible.

**Technic of Rectal Palpation** By rectal palpation is determined the

condition of (1) the anus and rectum, (2) the prostate gland, (3) the seminal vesicles, (4) the ampullae of the vasa deferentia, (5) the bulbo urethral glands

It is better to examine the prostate directly after the patient has voided his urine. Some examiners prefer to empty the bladder by catheterization, followed by irrigation. When the irrigating fluid returns clear, the bladder is partly filled with boric acid solution or normal saline, which is retained while the prostatic examination is being made. Others claim that the partial filling of the bladder pushes the prostate downward and so changes its relations that a true estimate of its size is impossible.

With the patient in the exaggerated knee-chest or other desired position, the examiner separates the buttocks with the fingers of the left hand and inserts his protected and well lubricated right forefinger within the anus, tactile surface upward. As the finger advances into the rectum, the prostate can be felt on the anterior wall about 5 cm beyond the anal sphincter. The normal prostate will be palpable as two ovoid lobes, jutting out very slightly of a firm and elastic consistency and sharply differentiated from the surrounding tissues. In front of the prostate lies the membranous urethra, usually about 2 cm in length. Normally, Cowper's glands, which lie on either side of the membranous urethra, cannot be felt, but if pathologically enlarged each may be palpated as a rounded mass in the perineum.

With firm but gentle pressure upon the anterior rectal wall, the trained finger can readily determine the size, contour, consistency, and sensitivity of the apex and the median and lateral lobes of the adjacent prostate. Important points to be noted are (1) the size and shape of the gland, (2) its surface, whether smooth, irregular, or nodular, (3) its consistency, whether elastic, boggy, fluctuant or hard, (4) its sensitivity, and whether the pain is generalized or limited to a certain portion of the gland, (5) its mobility, whether freely movable or fixed in position by adhesions or infiltration.

Pain produced by pressure on the median lobe is usually attributable to the prostatic urethra, the verumontanum in particular. If pain is felt during pressure on the lateral lobes the causal factor is probably located in the prostate gland itself.

Increased firmness and elasticity of the prostate is indicative of adenomatous hypertrophy. Stony hardness immediately suggests malignancy, especially if the normal contour is interrupted by even slight

tumefaction. However, a tuberculous prostate also feels nodular, and palpation alone will not suffice to establish the differential diagnosis. This is especially true if the tuberculous infection is accompanied by benign adenomatous hypertrophy, or if digital examination reveals hard nodules in the prostate of a man of cancer age. The chronically inflamed gland has a granular feel that is hard to describe but easily recognized after a little experience. Ordinarily, the pressure of the examining finger is painful and sometimes exquisitely so, although palpation is not so distressing in chronic conditions as in acute inflammation.

Proper palpation of the vesicles requires that the palpating finger be kept fully extended. Through the rectal wall the normal vesicle feels like an elongated, ovoid, soft mass extending at an angle from the base of the prostate on either side. It is indistinct in outline, somewhat mobile, and not sensitive—the patient experiencing pressure but no pain. The physiologically distended vesicle, on the other hand, is distinctly painful. It is only by becoming thoroughly familiar with the normal feel of the vesicle that one can hope to recognize pathological changes promptly.

*The index finger of the right hand is introduced into the rectum nail downward. When the finger tip has penetrated about one inch, its position should be reversed so that the nail comes uppermost and its tactile surface is toward the position of the right seminal vesicle as the finger is gradually advanced forward and sideways. The vesicle should be palpated from its extreme tip down to its junction with the cord. By carefully keeping his index finger, wrist, and forearm extended in a straight line, the examiner can reach the top of the vesicle in the majority of patients unless he has a forefinger shorter than the average. Occasionally, in an obese patient with fat, flaring buttocks, only the lower section of the vesicle, nearest the prostate, can be reached, but if this portion is found to be diseased, it may be assumed that the remainder is likewise affected.*

The examiner should note whether the vesicles are swollen and boggy, small, thickened, nodular, or calcified. It is only when greatly enlarged that the vesicles meet in the middle line, when normal, there is usually space enough between them to insert a finger.

On completion of the examination a diagram is made of the prostate and both vesicles, on which are indicated any areas that feel abnormal to the palpating finger.

Rectal examination of the prostate and vesicles is concluded by the expression of secretion for microscopic examination by massage and stripping

*Microscopic Examination of Prostatic and Vesicular Secretions* The microscopic examination of the secretions of the prostate and seminal vesicles secured by massage and stripping is an essential part of rectal examination and is discussed in greater detail farther on

Massage of the prostate is accomplished by exerting gentle but firm pressure with the end phalanx of the index finger upon a definite area of the gland using a downward stroking motion with the force directed inward toward the urethra The massage is continued until the entire posterior portion of the prostate—that part of the gland palpable by rectum—has been covered

Stripping of the vesicles is also accomplished by the flat surface of the end phalanx of the finger The strokes should be slow and uninterrupted and should cover the gland from the terminal pole to the ejaculatory duct Four to six strokes to each vesicle are usually sufficient

Since the prostatic and vesicular contents can easily be contaminated in their passage through the urethra we prefer to gather the specimens through a sterile endoscopic tube The patient having voided his urine the penis and meatus are cleansed with green soap and water and the anterior urethra irrigated with rivanol dextrose acriflavine or other antiseptic solution The patient then kneels on the table and a small sterile endoscopic tube is inserted to a point beyond the external sphincter into the prostatic urethra He then bends over and rests on his hands or elbows The prostate is massaged and each vesicle stripped in turn the prostatic urethra being emptied by several vigorous strokes of the examiner's fingers down the middle depression of the prostate The prostatovesicular secretion is received in a sterile test tube which the assistant holds at the end of the endoscope

This method may also be used for the separate collection of the secretions from the prostate and each vesicle care being taken during massage of the prostate to avoid the vesicular areas

The separate secretions from the three organs may also be recovered from the bladder contents voided immediately after massage and stripping The patient having voided his urine the bladder and urethra are irrigated with rivanol dextrose or acriflavine 1:5000 and the bladder filled with the solution The prostate is massaged thoroughly care being taken to avoid the vesicular areas The patient

immediately voids—the voided urine containing the prostatic secretion. The bladder and urethra are again irrigated, the bladder filled with solution, and the right vesicle stripped. The patient again voids—the voided urine in the second container containing the secretion from the right vesicle. The process is repeated for the left vesicle.

The normal prostatic secretion is opalescent and slightly viscid, and, microscopically, contains corpora amylacea, lecithin globules, columnar epithelia and occasional hyaline globules. The seminal vesicular secretion is a whitish, gelatinous fluid usually showing, microscopically, spermatozoa. The secretions should be examined for pus cells, red blood cells, bacteria, and the condition of the spermatozoa. (See also *Massage of the Prostate*, p 935, *Massage and Stripping of the Seminal Vesicles*, p 564, *Normal Prostatic Secretion*, p 802, *Seminal Fluid*, p 526, *Examination of Prostatic Secretion*, p 814, *Examination of Seminal Vesicular Secretion*, p 541)

**Palpation of Penis, Urethra, and Scrotal Contents** Palpation of these structures adds considerable to the data gained by inspection. Irregularities, indurations, and areas of tenderness should be carefully noted, and obscure circumscribed fibrosis in the corpora cavernosa identified.

In palpating the urethra, it is desirable to insert a sound of a size just large enough to fill the lumen of the canal without distending it. A careful search should then be made for infiltration upon the wall of the urethra. Externally, only the anterior urethra is palpable. Examination of the membranous portion must be conducted through the rectum, and it is seldom possible to palpate the prostatic urethra by any route.

Palpation of the testicle, epididymis, and vas deferens requires much practice and discrimination on the part of the examiner before he is able to gain any material diagnostic aid therefrom. Changes in the size or feel of the vas can be recognized by following it with the finger up from the epididymis, where it begins, to the inguinal canal. The chief points of interest about the testicle are its location and its size and consistency as compared with that on the opposite side. The size and consistency of the epididymis and the existence of certain pathological conditions, such as hydrocele, varicocele, etc., may also be determined by palpation.

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## CHAPTER II

### EXAMINATION OF THE URINE

Urinalysis, like all forms of laboratory investigation, is of no value unless it is accurate. If the results are not absolutely dependable, the time spent in doing the work will be worse than wasted for the examiner may be misled into all manner of errors.

In examining the urine, the findings that have particular diagnostic value to the urologist are (1) clinical, (2) physical, (3) chemical (4) microscopic, (5) bacteriological, and (6) by animal inoculation.

#### A COLLECTION OF URINARY SPECIMENS

**The Single Specimen** In making routine chemical and physical examinations, it is usually sufficient to use a specimen of freshly voided urine. In life insurance examinations, and other situations where the findings may have a medico legal significance, freshly voided urine is considered of particular importance.

The patient deposits the specimen in a suitable container, provided by the examiner, if possible, so that it will be uncontaminated and of sufficient capacity. The examiner then inspects it for blood, pus, and phosphates. A portion may also be centrifuged, to secure sediment for microscopic examination.

The single specimen is, however, a doubtful index to conditions prevailing in the urinary tract. Although it frequently yields valuable information, such data must be correlated with the findings of other examinations. The urine loaded with glucose, for example, is one of the most characteristic features of diabetes. On the other hand, a healthy person may pass a considerable amount of glucose under certain conditions. The fluid and food intake, the amount of exercise, the season of the year, even the subject's mental state, all influence the make up of the urine. As the composition of normal urine constantly varies from one hour to another, it is evident that in disease such variations will be even more pronounced. The acidity of the urine also varies at different periods of the day, and it may be quite impossible to establish a proper relation between

symptoms and microscopic elements, such as crystals, casts, or cells. The convulsions induced by the growth of a cerebral tumor may be immediately followed by a shower of casts in the urine, but if urinalysis were delayed until the lapse of a longer interval after the seizure, no casts whatever would be found.

It is evident, therefore, that a single specimen, taken at random, can not be relied on as a basis for final diagnosis, for conclusions drawn from such an investigation might be most misleading.

**The Twenty-four-hour Specimen** When it is desired to secure a twenty-four-hour specimen, a convenient hour is selected to begin the collection of the urine—say, at noon. The patient should be instructed to empty his bladder at this hour and to discard this voiding. Thereafter he should save all the urine voided up to and including that passed at noon of the following day.

He should not deviate from his regular diet and activities when a urine examination is to be made. But, if the examiner regards the regular diet as being excessive in meats, or otherwise unbalanced, he should make a note of this, as well as of any medicines the patient may be taking.

**Preservatives** Refrigeration is the best and simplest preservative. Chemical preservatives include thymol crystals (1 crystal to a single specimen, 4 or 5 to the 24-hour specimen), chloroform or toluol (4 cc. to each 100 cc. of urine), and formaldehyde (1 cc. to each 100 cc. of urine).

**Obtaining Specimens from Female Patients** To obtain a specimen of urine from an adult female, it is wiser to use a catheter, thus avoiding possible admixture of vaginal secretions.

In a large office or clinic practice, it is well to give the patient printed directions for the collection of urine when catheterization is not practical. The procedure is explained to her at the office, and she is provided with two wide-mouthed specimen bottles, cotton sponges, and bichloride or oxy-cyanide of mercury solution 1:1,000 or directions for making the same.

She is instructed first to cleanse the vaginal orifice with sponges soaked in the antiseptic solution. With the index and middle fingers of the left hand the lips of the vagina are held apart while the vulva is cleansed by rubbing slowly from above downward with sponges. The sponge should never be rubbed a second time over the meatus, but is thrown away and another used to repeat the downward cleansing. A third sponge, squeezed out in the solution, is inserted into the vagina to prevent the escape of any vaginal discharge. A bottle is then placed directly over the meatus, into which the urine is passed. Urine is voided into separate

bottles the last thing at night and immediately on rising in the morning, or, if the patient voids any during the night, it is passed into the morning bottle and the morning urine added later. The patient is instructed to present herself a few hours after the morning voiding having passed no urine in the interval, and a third specimen is obtained at the office.

This method permits the application of the two glass test to the female and allows the collection of an uncontaminated specimen even during menstruation, should this be necessary.

**Obtaining Specimens from Infants** The difficulties surrounding the collecting of urinary specimens from infants have resulted in a tendency to neglect urinalysis of these very young patients. During recent years however, considerable study has been given to the urological conditions occurring in young children, and this has created a demand for instruments adapted to pediatric work. Cystoscopes and catheters, suitable in size and shape for use in small children are now available and make possible the catheterization of even very young infants.

A child, if not too young, may be placed on a bedpan, but several attempts may be necessary before a specimen uncontaminated by feces is secured. Urinals of china or strong glass, especially designed for infants, are procurable from hospital supply houses. These may be retained in position by a muslin "specimen belt" with a small flap attached to its center. Through a firmly bound buttonhole in this flap the urinal is inserted over the vulva and held firmly in place by muslin straps encircling the buttocks. For a male infant, a test tube, into which the penis can be inserted, is usually more satisfactory. The edge of the cup, or tube should be protected with adhesive.

**Obtaining Sterile Specimens of Urine for Microscopic Examination and Culture** To obtain uncontaminated specimens of urine for microscopic examination from male patients, it is usually satisfactory to have the patient void into a sterile receptacle, provided the meatus is cleansed with green soap and water followed by oxycyanide or bichloride of mercury 1:1,000 and the first part of the urine is discarded. In the female, a catheter should always be used.

For culture, a voided specimen from the male is usually sufficient if collected under aseptic conditions. After cleansing the meatus, have the patient void into sterile receptacles as for two glass specimens and obtain 5 cc. of urine for culture during the second glass specimen. Flame the test tube before and after placing the urine in it. In the female, a catheter should always be used. About 6 cc. of urine is required for routine

culture The tube should not be filled When examining for tubercle bacilli, about 150 cc of urine in a sterile 180 cc bottle is required

Catheters used for obtaining specimens for culture should be boiled or exposed to steam rather than immersed in oxycyanide of mercury or other antiseptic solution as some of the antiseptic may adhere to the catheter and kill the bacteria When such a solution is used for sterilization, the catheters should be rinsed off in sterile water before being used

## B. THE CLINICAL TESTS

The use of one of the various glass tests is a simple and usually a reliable aid in deciding from which part of the urinary tract certain suspicious constituents of the urine are derived The three glass test is the one most commonly used In any of the glass tests it is essential that the patient retain his urine for several hours prior to the examination

**The Two glass Test** In this test the urine is voided into two containers That received in the first is the washings from the entire urethra and that in the second any secretions which may have entered the urine from the posterior urethra prostate or bladder

If the urine in the first glass appears cloudy while that in the second is clear, one can safely conclude that the condition is an anterior urethritis though occasionally there may be inflammation of the posterior urethra with comparatively little discharge so that no pus makes its way back into the bladder and the condition thus escapes detection

If antero-posterior urethritis exists both glasses will contain cloudy urine It may happen however that the urine in the first glass did not completely wash out the anterior canal and some clouding of the second glass will take place even when the disease is present only in the lower section

**The Three glass Test** Slightly more intricate but of greater value than the method just described is the three glass test which is usually conducted as follows

Three receptacles are provided into which the patient voids his urine in a continuous stream beginning with Glass No 1 then substituting Glass No 2 and finally Glass No 3 when he feels that the bladder is fairly well contracted Into Glass No 1 will be voided the washings of the entire urethra in Glass No 2 will be found uncontaminated bladder urine and in Glass No 3 will be bladder urine combined with the stripings from the prostate and urethra pressed out during the final contractions of micturition

An even greater degree of accuracy may be secured by the following modification of this test

The anterior urethra is first irrigated until the washings come out clear, Glass No 1 thus showing the condition of the anterior urethra The bladder content is next drawn off by catheter into Glass No 2, which therefore shows the bladder urine plus any drippings from the posterior urethra or urethral detritus carried in by the catheter Through the catheter, which is left in for the purpose, the bladder is then thoroughly irrigated until the washings run clear of all pus and shreds About 200 cc of clear fluid is now injected into the bladder, the catheter withdrawn, and 50 cc of the bladder content passed into Glass No 3 As the anterior urethra and bladder have been thoroughly irrigated when the patient voids the clear water into Glass No 3 the appearance of the fluid will indicate the condition of the posterior urethra

This method permits the mechanical collection of separate specimens from the three portions of the urinary tract If it is desired to go into further detail the prostate may be massaged and 50 cc of fluid thereafter passed into Glass No 4, which will show the condition of the prostate after massage

**Wolbarst's Five-glass Catheter Test** The patient presents himself with a full bladder, having retained his urine for several hours After the meatus has been cleansed, the anterior urethra is thoroughly irrigated with sterile water or a bland solution, about 100 cc of irrigating fluid usually being sufficient The washings are collected in a receptacle designated as Glass No 1 The anterior urethra is again irrigated, to insure its absolute cleansing and the clean washings collected in Glass No 2

Through a sterile small catheter, 25 or 50 cc of urine is drawn off into Glass No 3 If this catheterized bladder urine proves clear and sparkling, it is an indication that pus and shreds seen in the voidings originate below the bladder The catheter being withdrawn, the patient voids 25 or 50 cc into Glass No 4 If the pus or shreds appear in this urine, it indicates that their origin is in the posterior urethra since both the bladder and the anterior urethra have been eliminated After vigorous prostatic massage, the patient voids into Glass No 5

If desired, each seminal vesicle may be separately massaged or stripped and the urine passed into two more receptacles Glass No 6 and Glass No 7

Should the catheterized bladder urine prove cloudy, the bladder should

be completely emptied and irrigated until the washings come out clear, the test being then resumed

If the patient's trouble is in the upper urinary tract, the cystoscope and ureteral catheter will, of course, have to be relied on but the five glass test prepares the way for such investigation by eliminating the lower urinary tract as a possible source of blood or pus in the urine

**The Seven-glass Test** The purpose of the seven glass test is to differentiate disease of the prostate from that of the seminal vesicles. The two vesicles and the ampullae of the vasa deferentia being widely separated from each other as well as from the prostate it is possible to massage or strip each vesicle with its ampulla separately from its fellow and from the prostate below. One must massage only the upper two-thirds of the vesicles, and great care must be taken to avoid their confluence at the point where they enter the base of the prostate. As ample specimens are essential (not less than 150 cc) the patient should retain his urine for several hours. If he is unable to do so, the bladder must be distended with sterile fluid.

The meatus having been cleansed the anterior urethra is irrigated from behind forward. This, of course, necessitates the use of a catheter the tip of which is passed to the bulb of the urethra. The washings are collected in Glass No. 1.

Glass No. 2, the anterior urethral control glass is secured in exactly the same manner. Both glasses thus show chiefly the contents of the anterior urethra—pus, shreds, epithelial debris etc. The urethra should be gently massaged upon the catheter, in order to express as large an amount as possible.

The patient next passes from 100 to 150 cc of bladder urine into Glass No. 3. If the bladder is normal, this glass will show mainly the contents of the posterior urethra. In uncomplicated cases the microscope will reveal in it the products of posterior urethritis when present in the presence of complications it will reveal the drainage products from the prostate and vesicles. If there is reason to suspect the presence of pus in the bladder, as well as disease of the posterior urethra it will be better to utilize the Wolbarst five glass test, passing a catheter into the bladder for Glass No. 3, followed by vesical irrigation.

For Glass No. 4, likewise known as the bladder glass the catheter is again employed. In this glass, only a few cubic centimeters of bladder urine are needed, to permit microscopic search for evidence of pyuria.

and, if this is found, to determine whether the pus is of vesical or renal origin

For Glass No 5, the prostatic glass, the bladder should be well filled with fluid, therefore, if an insufficient quantity of urine now remains, about 500 cc of sterile water, saline, or boric acid solution should be injected while the catheter is still in place. The catheter is removed, and the prostate carefully massaged along the lateral borders of the lateral lobes, avoiding the course of the ejaculatory ducts along the urethra at the middle of the prostate. Following the massage, the patient voids 150 cc of urine, thus presenting prostatic secretion for examination.

The vesicles are now massaged in turn, the products of the massaged organs being evacuated by the patient into separate containers, Glass No 6 and Glass No 7. Sufficient fluid should be kept in the bladder to permit the evacuation of at least 150 cc into each glass.

As the seven glass test requires considerable skill in massaging the prostate and vesicles, it can be undertaken only by one who is well experienced in this form of manipulation, and is therefore not always practical for routine office work.

### C THE PHYSICAL TESTS

Not only must the chemical, microscopic, and bacterial content of the urine be considered in the gathering of diagnostic data, but the character of the urine as a whole should undergo thorough scrutiny by every careful examiner.

**The Color of the Urine** Normally, the color of freshly voided urine varies from pale yellow to amber, depending upon its specific gravity. The yellow color is due to the presence of several pigments, chiefly urochrome. Acid urine is generally darker than alkaline urine.

In pathological states, the color of the urine may vary greatly, from practically colorless to dark brown or even black. Abnormal pigments sometimes change the color. Thus, blood pigment gives a red or smoky brown color, depending on the amount of blood in the urine and whether the bleeding is fresh or old. Biliary pigments give the urine a greenish brown color, with a yellowish or brown foam when the container is shaken, or it may assume a greenish hue upon standing owing to the oxidation of the bilirubin into biliverdin. The presence of melanin, usually but not always due to melanotic sarcoma, gives the urine a brown or black color upon long standing. A milky or cloudy appearance may be the result of pus, bacteria, crystals, or chyle in the urine.

Unusually dark or otherwise abnormally colored urine may be caused by medicines ingested. Methylene blue, taken in small amounts, gives a pale green shade, while large amounts produce blue. Santonin produces a yellow color, while rhubarb, senna, and cascara produce brown. Salicylic acid, pyridium, and acriflavine produce a dark yellow or reddish yellow color, sulphonal, trional, fuchsin, a red color, thymol, a yellowish green, and phenol, tannin, resorcin, and guaiacol cause the urine to become olive green varying to brownish black upon long standing, although the color may be normal when the urine is voided.

**Cloudy Urine** Freshly passed normal urine is clear. Upon standing, mucus, leukocytes, and epithelial cells settle to the bottom.

Cloudiness is commonly due to the presence of pus, blood, or bacteria, but may be caused by lymphocytes, chyle, or precipitated phosphates, urates, oxalates, or carbonates. The heat and acetic acid tests are of some practical differential value, but the only sure test is the microscope.

*Amorphous phosphates* are precipitated in neutral or alkaline urine. They form a white cloud and sediment which disappear upon the addition of acetic acid.

*Amorphous urates* are precipitated only in acid urine. They form a white or pink cloud and sediment (brick-dust deposit) which disappear upon heating.

*Oxalate crystals* are commonly seen in the urine, but seldom in sufficient quantities to cause cloudiness. They do not dissolve with the heat and acetic acid tests and are easily recognized microscopically by their octahedral form.

*Chyluria* denotes the presence of chyle or lymphatic contents in the urine, giving it a milky appearance. It may be either parasitic or non-parasitic. The parasitic type is due to the presence in the blood of a nematoid parasite, *Filaria sanguinis hominis*, and occasionally to the echinococcus, *Cysticercus cellulosae*, or *Ascaris lumbricoides*. Non-parasitic chyluria may be associated with diabetes, tuberculosis, pregnancy, aneurysm of the lymphatics, obstruction of the thoracic duct, or any process resulting in lymphatic obstruction, provided the collateral lymphatic circulation is inadequate.

*Pus* resembles phosphates to the naked eye, but is easily detected by the microscope or by Donne's test (adding a strong solution of caustic soda to the sediment which is thereby transformed into a gelatinous mass).



*Blood* gives a reddish or smoky brown color and may be recognized by the microscope or by tests for hemoglobin

*Bacteria*, when present in great numbers, give a uniform cloud which cannot be removed by ordinary filtration They are detected with the microscope or by culture

*Shreds* in the urine indicate chronic inflammation of the urethra and its accessory glandular structures The long, light filaments signify superficial mucosal inflammation, the heavy, thick shreds contain pus cells, and the comma shaped shreds indicate chronic infection of the prostate and urethral glands

**The Odor of the Urine** The characteristic aromatic odor of fresh normal urine is due to the presence of volatile acids, and is most marked in urines which are highly concentrated It quickly changes, on exposure of the urine to the atmosphere, to a disagreeable ammoniacal odor due to the presence of the products of bacterial decomposition Freshly voided urine from patients suffering from alkaline cystitis has a similar but even more intense ammoniacal odor Certain foods and medicines change the odor of the urine A "fruity" odor is sometimes noted in diabetes, due probably to acetone Cystine may develop an odor of sulphurated hydrogen during decomposition

**The Quantity of the Urine** The daily output of urine is proportional to the weight (about 25 cc per kilo in the adult), but is directly influenced by the intake of fluid, substances to be excreted and the loss by perspiration The normal output varies from 800 to 2,500 cc, averaging about 1,200 to 1,800 cc Less than 800 cc indicates an oliguria, more than 2,500 cc, a polyuria

The quantity is increased in many constitutional diseases notably all forms of diabetes, as well as in such renal affections as amyloid degeneration or contraction of the kidney It is also increased by the use of certain drugs, such as digitalis caffeine, and the salicylates

The volume is decreased in certain diseases of the kidneys especially all forms of inflammation, as well as in diseases of the heart and lungs and in any affection attended by marked elevation in the body temperature It is also diminished in the presence of excessive vomiting, protracted diarrhea, or any other condition which deprives the body of fluid by another route

The frequency with which urine is voided is also subject to individual variation, depending upon habit, bladder capacity, and numerous other

normal factors. A variety of pathological conditions may induce more frequent evacuation: an actual increase in the amount of urine excreted, infections and irritations of the posterior urethra, prostate and bladder, leading to abnormal stimulation of vesical contraction, obstructive lesions of the urethra, prostate, or bladder, resulting in diminution in the amounts voided, psychic factors, diseases of the spinal cord, producing overstimulation of vesical contraction or weakening of sphincteric control.

**The Specific Gravity of the Urine** The determination of the specific gravity of the urine is one of the routine procedures without which no urinalysis is considered complete. Tests of specific gravity are of particular importance to the internist and have little practical value in urology. The normal specific gravity of urine averages about 1.015 to 1.025. Pathologically, it may vary from 1.001 to 1.060.

The specific gravity is low in diabetes insipidus, chronic interstitial nephritis, and many functional nervous disorders. It is high in fevers and in parenchymatous nephritis. In acute nephritis it is high and the solid constituents of the urine much concentrated. The specific gravity is highest in diabetes mellitus, and a high specific gravity when the urine is not deeply colored should lead one to suspect the presence of this disease, though a normal specific gravity does not exclude it.

The most convenient means of estimating the specific gravity is by the use of the urinometer. Squibb's urinometer is adjusted to give accurate readings at 22.5° C. For accuracy, it is necessary to add 0.001 to the urinometer reading for each 3° C. above the temperature for which the instrument is standardized, and to subtract 0.001 for each 3° C. below that point. The urinometer should not touch the side of the tube, and air bubbles should be removed from the surface of the urine by filtering paper.

#### D. THE CHEMICAL TESTS

**Tests for Albumin and Sugar** The chemical tests for albumin and sugar are usually of greater importance to the internist than to the urologist, but in a complete diagnosis they should not be neglected.

*The heat and acetic test for albumin* has its basis in the fact that albumin is coagulated either by heat or strong acids. The test is done as follows: Fill a test tube two-thirds full of urine, add about 5 drops of 2 per cent acetic acid, and boil at the top, holding the tube at the bottom and directing the flame against the upper portion of the fluid. Add a few more

drops of acetic acid, then examine the tube by transmitted light against a black background for clouding in the top portion as compared with the portion just below it. If the precipitate is flocculent, take the tube in a holder and heat the entire contents to boiling and stand the tube in a rack. When the precipitate has settled (15 minutes or more later), mark the percentage of albumin according to the estimated proportion of the column of urine occupied by the sediment. The result may be reported as "very faint trace," "faint trace," "trace," "marked trace," or "very marked trace."

*For the Fehling test for sugar*, place 5 cc. of Fehling's solution in a test-tube and heat to the boiling point. Then add 3 cc. of suspected urine. The color of the solution varies with the amount of sugar in the urine. A red or golden yellow precipitate is a positive sugar reaction.

*For the Benedict test*, place 2 cc. of Benedict's solution in a test tube with 10 drops of urine, and boil for 2 minutes. If the fluid becomes opaque, sugar is present.

*The Galatest for sugar* has certain distinct advantages over other commonly used tests, namely (1) It can be made instantaneously (about 30 seconds), in the physician's office or at the bedside of the patient, without any complicated laboratory equipment, (2) because of the simple technic required, error resulting from faulty procedure is eliminated, (3) diabetics are easily taught to use the test, (4) the reaction is not interfered with by large amounts of albumin, creatinine, uric acid, or urates.

Galatest is a dry reagent composed of a bismuth salt, sodium hydroxide, and sodium silicate. In the presence of a reducing sugar, the gray or black color which results is caused by the formation of finely divided, partly colloidal, metallic bismuth. The reagent is put up in vials containing enough powder for 100 tests.

To make the test (1) Shake the vial well, (2) deposit on a piece of plain whitepaper a little of the powder (covering an area about the size of the little finger nail), (3) replace the cap on the vial, screwing it on tightly to exclude air and moisture, (4) with a dropper, deposit *one small* drop of urine on the powder. Do not flood the powder with urine, if this occurs, repeat the test, using one *small* drop of urine. If sugar is present in any pathological degree, that is, 0.1 per cent or over, the powder will instantly turn gray or black, depending upon the amount of sugar present. Black indicates 1.0 per cent or over. If sugar is not present, the white powder takes on the color of the urine. Pink, reddish, or orange colors occasionally appear. These may be due to malic acid, urea compounds, or to

medicines which the patient may have taken, but they never indicate sugar and are of no clinical significance

**Test for Acetone** When acetone can be demonstrated in the urine, the condition is termed *acetonuria*. It is seen in the following: starvation, chloroform poisoning, diabetes mellitus, a few forms of digestive disturbance, sometimes in malignant disease, and occasionally in perfect health. The urine has a peculiar 'fruity' odor.

To test for acetone, prepare a fresh aqueous solution of sodium nitroprusside by placing 1 crystal of the salt in 10 cc of water. To 5 cc of urine add 2 cc of sodium nitroprusside solution and a few drops of glacial acetic acid. Concentrated ammonium hydroxide is then stratified upon the mixture. A magenta color at the point of contact of the fluids indicates the presence of acetone.

**Test for Diacetic Acid** Diacetic acid is found in the urine under much the same conditions as those producing acetone. The condition is termed *diaceturia*.

To about 10 cc of urine in a test tube add drop by drop a few drops of 10 per cent ferric chloride. If a precipitate forms, filter and add a few more drops of ferric chloride. A Burgundy red indicates the presence of diacetic acid.

**The Reaction of the Urine** Normally, the urine is acid in reaction, though individual samples may be slightly alkaline. For practical work, the reaction may readily be determined by the use of litmus paper. The reaction should always be determined from freshly voided urine.

The acidity of the urine is increased by the use of certain drugs and in most diseases, particularly those affecting the heart and kidneys. It is also increased in fevers.

Upon long standing, urine becomes alkaline owing to decomposition of the urea with the consequent formation of ammonia. If the urine is alkaline when voided, it usually indicates ammoniacal decomposition in the bladder, which is the rule in chronic cystitis, especially when the condition is due to paralysis or obstruction. Marked alkalization is associated as a rule with urea splitting organisms such as *Bacillus proteus vulgaris* or *Micrococcus urea*. Normally, alkalis are quickly neutralized by the kidneys, but examination of urinary specimens voided shortly after the ingestion of alkaline substances may show an alkaline reaction in a perfectly healthy person.

*Determining the Hydrogen Ion Concentration (pH) of Urine* The

normal hydrogen ion concentration of the urine is about pH 6. It is possible for the urine to show a pH in health varying all the way from an acidity of 4.85 to an alkalinity of 8.0.

Measuring the pH of the urine is important in a wide variety of pathological conditions in which it is necessary to know the degree of alkalinity or acidity of the urine. There are numerous methods of doing this, most of them requiring a degree of technical skill that precludes their routine employment in the general practice of medicine.

Two simple and accurate methods, employed by us at the Brady Foundation, of the New York Hospital, are given here. All tests of reaction must be made on fresh specimens of urine.

**THE NITRAZINE METHOD** Nitrazine, a very sensitive indicator of hydrogen ion concentration, is available both as a 0.1 per cent solution in dilute alcohol and in treated paper strips which give the color reaction and at the same time retard solution and dissipation of the reagent. Of the many indicators that have been introduced for the determining of the hydrogen ion concentration, litmus is perhaps the most popular, because of its favorable pH range. Nitrazine changes color within approximately the same range as litmus (4.5 to 7.5), but is more sensitive and the color changes are much more definite, so that differential readings can be made over smaller pH intervals. When using nitrazine test solution, the reaction is immediate and permanent. With nitrazine paper, the reading must be made within a minute or two after applying a drop of the solution to the paper. The paper should not be exposed to the air or light, as it decolorizes. The test should be made under daylight or using a blue bulb. A morning specimen of urine (the second voiding) is preferable.

When using the nitrazine test solution, two drops (from a pipet dropping  $\frac{1}{3}$  min. drops) are added to 5 cc. of solution to be tested (urine). The reaction is immediate and the colors persist indefinitely. The pH range of nitrazine test solution is 5.3 to 8.0, with a neutral point at about pH 6.6. The color values are given in Table I.

When using the nitrazine paper, the paper should be dipped only momentarily into the solution, as otherwise solution of the dye from the paper into the liquid will occur. The color change in the paper takes place gradually during the first minute, reaches a suitable value for reading in about 60 seconds, and remains readable and of the same color for another 60 seconds. The range of color gradations for nitrazine paper is

TABLE I

*Color values (with 2 drops of nitrazine test solution in 5 cc. of buffer—no time limit)*

4 0 yellow	6 4 deep olive
4 5 yellow	6 6 olive gray
5 0 yellow	6 8 gray blue
5 3 yellow	7 0 deep gray blue
5 7 duller yellow	7 3 paler blue
6 0 light olive	7 6 pale blue
6 2 deeper olive	8 0 blue

TABLE II

*Color values (on dipping nitrazine paper into solution to be tested)*

	AFTER 15 SECONDS	AFTER 100 SECONDS
4 0	yellow	deep yellow
4 5	yellow	bright yellow
5 0	yellow	bright yellow
5 3	deep olive yellow	mustard yellow
5 7	faint olive yellow	olive green with yellow cast
6 0	no change	olive green faintly yellowish cast
6 2	no change	olive green faint bluish cast
6 4	no change	olive green faint blue cast, deepening
6 6	neutral with bluish cast	bluish
6 8	green blue	blue green
7 0	greenish blue	bluer blue-green
7 3	gray blue	blue
7 6	sky blue	deeper blue
8 0	pale blue	deep blue

TABLE III

*Color values on nitrazine paper (solution applied with glass rod)—read in from 60 to 120 seconds*

4 0 bright yellow	6 4 slightly stronger bluish cast to olive green
4 5 yellow, slightly duller (lemon yellow)	6 5 dark green
5 0 mustard yellow	6 6 blue-gray
5 3 light olive yellow	6 8 dark blue-gray
5 5 olive yellow	7 0 gray blue
5 7 olive green yellow cast	7 3 deeper blue
6 0 olive green	7 6 same
6 2 bluish cast to olive green	8 0 same

very wide, making it possible to use it to determine the approximate pH of solutions from about 4.5 to 7.5. The color values are given in Table II.

A more satisfactory means of utilizing the nitrazine paper is to dip a

glass rod into the solution to be tested (urine) and transfer enough fluid to the paper, by stroking it, to wet one end of it. The color change takes place gradually during the first minute and remains accurately readable for about one more minute. The color values, by this method, are given in Table III. A color chart, reproducing the range of colors for  $pH$  4.5 to 7.5 by half units, accompanies the nitrazine paper, and may be used for approximate determination of hydrogen ion concentration of solutions. These color values are underscored in Table III.

**COLORIMETER METHOD (WITH HELBIGE COLORIMETER)** An equally simple and satisfactory method, but one requiring a more expensive equipment, is the following:

The urine is first tested with litmus paper, to determine whether it is acid or alkaline. Acid and alkaline indicators are used (methyl red solution,  $pH$  4.4–6.0, bromthymol blue, 6.0–7.6) and corresponding color discs, which are read with a Helliger colorimeter.

*For determining the  $pH$  of acid urine*, 0.2 cc. of methyl red solution is added to 10 cc. of urine in a right hand tube. Ten cc. of plain urine is placed in a second (left) tube and used as a control for density. When the colors are matched, the  $pH$  is shown on the opposite side of the disc.

*For alkaline urine*, 0.5 cc. of bromthymol blue indicator is added to 10 cc. of urine in the right hand tube and 10 cc. of plain urine is placed in a second tube.

If the urine is too turbid, it is centrifuged and the sediment discarded.

## E. THE MICROSCOPIC TESTS

**Urinary Substances Detectable by Microscope** The chief substances in urine detectable by the microscope are red blood cells, white blood cells or leukocytes, pus cells, epithelial cells, connective tissue fibers, bacteria, the ova of parasites, and crystals.

**Red Blood Cells** Hematuria ( $p$  7) is one of the most prominent and significant of urinary symptoms. It may be due to a variety of causes, but usually indicates some serious disease or lesion and demands prompt investigation. The amount of blood in the urine may be so small as to be invisible to the naked eye or so great that the fluid passed from the urethra has the appearance of pure blood. The only sure test of hematuria is the microscope, which will detect any red blood corpuscles.

**Hemoglobinuria**—the presence of blood pigments in the urine—also gives the urine a bloody appearance, and certain drugs such as rhubarb, senna, and sulphonal, have a similar effect.

**Pus Cells** Pyuria is a common finding. It varies from an occasional pus cell, which cannot be accounted for, to such an outpouring of pus (as from rupture of an abscess in the urogenital tract) that the urine is milky white. A small amount of pus gives the urine a cloudy look.

Pus corpuscles in the urine, even if very few in number, are a positive indication that a pathological process is at work somewhere in the urinary tract. If present in very small amounts they may indicate merely that an irritation exists, if more numerous, they are invariable proof of an inflammatory process, while the presence of a great quantity points positively to a diagnosis of ulceration or suppuration which must, however, have further confirmatory proof.

**Epithelial Cells** Three kinds of epithelial cells—flat, cuboidal, and columnar—are found in the genito urinary tract. Sometimes the epithelial lining is of a single thickness, again, it is stratified into three layers. It is where the lining takes the stratified form that one may find, at a single point all three types of cells: the deepest layer, adjacent to the connective tissue, being composed of columnar cells, the middle layer of cuboidal cells, and the top stratum of flat cells.

The excreted urine normally contains a certain number of flat cells desquamated from the bladder in both sexes and in the female, from the vagina also. If other types of epithelial cells are found they are of pathological origin.

Flat epithelial cells are irregular in outline, presenting a broad front surface, the cuboidal are round or oval, having the same diameter in all directions, while the columnar are elongated in one direction or somewhat cylindrical. All epithelial cells are granular, with one or more nuclei, which may or may not be seen or which may have dropped out leaving a vacuole. The granulation is either coarse or fine, the flat being finely granular, the columnar coarsely so, and the cuboidal presenting an intermediate degree of granulation. Epidermal scales from the prepuce in the male and the clitoris and labia in the female, or from the fingers of the examiner while handling the slides and covers, may occasionally introduce an element of confusion. These, however should be easily distinguished from epithelial cells as they contain no nucleus and are highly refractive, presenting a jagged outline.

**Connective Tissue Fibers** The presence of connective tissue threads in the specimen is an indication that the pathological process has penetrated below the epithelial lining. Under the microscope these fibers appear moderately refractive, the wavy threads being combined in small



bundles, sometimes so minute as to be barely visible even under a 450 lens, or again so large as to occupy a great part of the visual field "Connective tissue corpuscles" is the name applied to those threads which have a granular appearance and contain within them formations bearing a certain resemblance to nuclei

If a malignant tumor is present in the urinary tract, the detection of these threads in the urine may provide the first tangible evidence of its existence In ulcerative processes they are of considerable size and very abundant When present in large numbers and accompanied by pus cells, they indicate suppuration or abscess formation

**Parasites and Ova** The eggs of parasites, such as the *echinococcus* or *Schistosoma hematobium*, are occasionally found in the urine, but unless the parasites are actually present in the urinary tract they are not likely to be found In no case are they as readily demonstrated as when they occur in the intestinal tract and can be detected in the feces

**Bacteria** The microscopic demonstration of bacteria in freshly collected urinary specimens has great diagnostic value and, in addition, acts as a control of subsequent cultural findings The most common organisms found in the urogenital tract are the *Bacillus coli communis*, staphylococci, streptococci, tubercle bacilli, *Proteus vulgaris*, and, in the lower tract, the gonococcus Mixed infections are common Absence of the pyogenic forms in a purulent urine is strong presumptive evidence of tuberculosis or gonorrhea

Stained centrifuged urinary sediments help to distinguish true infections from contaminations, give information regarding the nature of the infecting bacteria, and reveal the predominating organism in mixed infections, which is not always accurately demonstrated by cultures Staining also demonstrates the presence of unusual bacteria which are not found by routine cultural examination

**Preparation of Specimen for Staining** When staining for the detection of tubercle bacilli, the examiner is often hindered by the density of the bacilli and the presence of pus and detritus But, as there is a marked difference between the density of tubercle bacilli and that of pus, it has been found possible to concentrate all the bacilli present in a considerable volume of urine so that cover glass preparations may be made in which the bacilli will be readily detectable as they are not obscured by a multiplicity of cells The technic is as follows

When a relatively large amount of pus is present in the urine, the specimen should be centrifuged for 1 or 2 minutes at the lowest speed a

heavy sediment of pus and detritus being thus deposited. The urine remaining above the sediment will have a cloudy appearance, and will hold in suspension a small number of pus cells and practically all the bacilli contained in the specimen. The urine should now be decanted into a clean tube, the sediment discarded, and the specimen again centrifuged at high speed until it is clear. This will require from 15 to 20 minutes. The urine may then be decanted and the tube containing the sediment refilled with partly clarified urine and again placed in the centrifuge, this procedure enabling the examiner eventually to concentrate the sedimentary contents of several tubes of urine into a single specimen of small bulk. Finally, the clear urine should be poured off and the tube inverted over an absorbent cloth which will take up the remaining moisture and leave the sediment practically dry. It can then be manipulated with a loop and removed for cover glass preparation or culture.

By centrifuging the urine until it is clear, deposit of bacteria is assured. This method is useful in determining the nature of infections other than tuberculosis. The performance of the Gram stain or the Ziehl-Neelsen stain, if indicated, will quickly show whether or not infection is present, and in addition will yield sufficient data regarding the nature of the organisms to permit carrying out of the proper cultural procedures.

*Staining for Tubercle Bacilli.* The sediment finally obtained is spread upon a clean glass slide, exposed to the air until perfectly dry, and then passed three times through a flame for fixation. When the search is for tubercle bacilli, stain the specimen as in examination of sputum which is commonly done by steaming in carbolfuchsin for 3 minutes, decolorize, and counterstain with Gabbett's solution (100 cc. of 25 per cent sulphuric acid and 2 grams of methylene blue). The slides should be held in this solution only 1 minute, then quickly washed in plain water, dried and immediately examined.

The discovery of acid fast bacilli is not invariable proof that tuberculosis is present. The smegma bacillus, an organism found in the urethra of both the male and female, is also acid fast. Urinary specimens are sometimes contaminated by this organism and, to avoid the possibility of error, guinea pig inoculation is usually employed as an additional diagnostic test.

*Staining for Organisms Other than the Tubercle Bacillus.* When the urinary sediment is to be examined for organisms other than the tubercle bacillus, the urine should be centrifuged and the urinary salts removed by

washing with sterile water. The residue is fixed in a flame, and may then be stained for a single minute in Roux's blue, the formula for which is:

<i>Solution A</i>		<i>Solution B</i>	
Violet dahlia	1 gm	Methyl green	2 gm
Absolute alcohol	10 gm	Absolute alcohol	20 gm
Distilled water	q s for 100 cc	Distilled water	q s for 200 cc

Prepare each solution separately by rubbing up the dye with the alcohol in a mortar and add the water gradually. Let the mixture stand for 24 hours in a bottle, then mix the two solutions, filter, and store in a well stoppered bottle.

Loeffler's methylene blue stain may also be used.

A Gram stain is of great value in differentiating bacteria, particularly the gonococcus. The following modification is recommended by Gradwohl as a permanent and reliable primary stain superior to the aniline-oil gentian-violet mixture, requiring fresh preparation for each examination. The urinary sediment is spread, aerated, fixed by passing through a flame, and stained for 60 seconds with carbol-gentian-violet, made up as follows:

Gentian violet	1 gm
Carbolic acid crystals	2 gm
Absolute alcohol	10 gm
Distilled water	100 cc

Rub up the gentian violet and the alcohol in a glass mortar, add the carbolic acid and mix, add two thirds of the water, stirring continuously, pour the mixture into a bottle, then rinse out the mortar with the rest of the water and add it to the mixture in the bottle. Leave for 24 hours and filter into a clean glass-stoppered bottle.

Blot up the excess stain (but do not wash), drop 2 or 3 large drops of Gram's solution of iodine (iodine, 1 gm; potassium iodide, 2 gm; distilled water, 300 cc) on the smear, and allow it to stain for 20 to 30 seconds. Wash in water and dry. Pour absolute alcohol over the film, a drop at a time, until no more violet stain comes away, usually 30 seconds. Wash rapidly in water. Counterstain for 1 minute with an aqueous solution of safranin. Wash in water, dry, and examine. Gram-positive organisms (streptococci, staphylococci, tubercle bacilli, *Micrococcus urea*, etc.) are stained a deep violet, and gram-negative organisms (*B. coli*, *B. pyocyaneus*, *B. proteus*, the gonococcus, etc.) a delicate light pinkish or safranin color.

**Examination of the Unstained Specimen.** Urinary sediments are usually studied under three heads: (1) unorganized sediments, (2) organized sediments, and (3) extraneous structures.

**Unorganized Sediments** Unorganized sediments are classified accord-

ing to the reaction of the urine in which they are most likely to occur. In acid urine are found uric acid, amorphous urates, sodium urate, calcium oxalate, leucin and tyrosin, cystine and fat globules. Of these, leucin and tyrosin may be regarded as pathologically important, and in certain conditions calcium oxalate occurs in such excess as to have a pathological significance. The phosphates, calcium carbonate and ammonium urate found in alkaline urine are of no pathological importance unless present in excessive amounts.

**LEUCIN AND TYROSIN** Leucin and tyrosin generally appear together in the comparatively unusual instances in which they occur. Their presence is usually indicative of severe fatty degeneration of the liver such as accompanies phosphorus poisoning or yellow atrophy. The crystals of leucin appear microscopically as oily spheres of a faint yellow tinge, often showing radial and concentric striations. They are soluble neither in hydrochloric acid nor in ether. The crystals of tyrosin appear as fine colorless needles arranged usually in sheaves, the middle portion being markedly constricted. They are soluble in ammonia and hydrochloric acid, but acetic acid has no effect upon them.

**CYSTINE** Cystine may be found in slight traces in normal urine, as it is one of the amino acids formed in decomposition of the protein molecule, but it is only when it is present in the urine in abnormal quantities that crystals are deposited—this constituting *cystinuria*, a rare condition due to some abnormality of protein metabolism. As the condition predisposes the individual to calcium formation, any symptoms present will usually be referable to lithiasis. The crystals of cystine are colorless and highly refractive, and appear as somewhat thick hexagonal plates with sharply defined edges. They will be found either singly or arranged in masses one above another.

**FAT GLOBULES** Fat appears in the urine in very small globules (though the size varies considerably) which are always highly refractive. Osmic acid changes their color to black, while the addition of Sudan II turns them red or orange. Fat globules are a common finding in chronic parenchymatous nephritis, fatty degeneration of the kidney, and phosphorus poisoning, and may be observed floating free in the urine or embedded in cells and tube casts.

**Organized Sediments** **TUBE CASTS** Albuminous casts of the uriniferous tubules of the kidney appear in the urine only when there is some pathological change taking place in the kidney, although this process may be so slight as to have no clinical importance.

Casts may appear in numerous forms (1) hyaline casts, both narrow and broad, (2) waxy casts, (3) fibrinous casts, (4) granular casts, both finely and coarsely granular, (5) fatty casts, (6) casts containing or ganized structures—epithelial casts, blood casts, pus casts, or bacterial casts

The examination of epithelial cells and pus corpuscles has already been considered

*Extraneous Structures* In addition to the above, many extraneous structures are found in the urine, from accidental contamination molds, fungi, starch granules, air bubbles, and yeast cells

## F THE BACTERIOLOGICAL TESTS

When inspecting the urine for gonococci and, less often, for other organisms, such as staphylococci or streptococci, it is necessary to resort to cultural methods The interpretation of cultural findings is subject to considerable individuality There are many factors which may influence the accuracy of the results the use of internal urinary antiseptics, the bacteriostatic action of hyperacid urine, the use of antiseptics to sterilize the catheters the length of time elapsing before transfer of the specimen to the medium, contamination of the specimen at the time of collection or in the course of transfer

*Collection of the Specimens* For bacteriological investigation, sterile specimens of urine are necessary (Obtaining Sterile Specimens of Urine for Microscopic Examination and Culture p 23)

*Making a Routine Urine Culture* In our practice, a routine urine culture is made as follows

The specimen of urine (which may amount to as much as 15 cc) is received in a sterile test tube Any excess is discarded, about 5 cc being retained in the tube To this is added an equal amount of nutrient extract broth, and the tube is incubated overnight (about 18 hours) If the urine appears to contain a large amount of pus either a dilution or streak plate is made at the same time

The following day a film is made and stained with Gram stain If more than one type of organism is seen, a dilution plate is made and the individual colonies fished and identified

Transfer is made from the broth culture to slant of Russell medium, and with this the colon bacillus is usually easily recognized If not, a typical colon bacillus complete identification of the organism follows If Gram positive cocci and Gram negative bacilli are both present, and

cannot be separated on the usual plate, resort to sodium carbonate containing media which inhibit the growth of Gram negative bacilli

**Detection of Tubercle Bacilli (Corper's Sulphuric-acid-crystal-violet-potato Method)** This method is useful for the detection of small numbers of tubercle bacilli in contaminated material. It is especially valuable when acid fast bacilli cannot be found in stained smears or when it becomes necessary to differentiate the type of bacilli present.

The procedure consists essentially in taking 1 cc of urinary sediment and introducing it into a sterile 15-cc centrifuge tube with 1 cc of 6 per cent sulphuric acid. After thorough mixing the tube stoppered with a sterile cork, is incubated at 37°C for 30 minutes, being shaken occasionally. The contents are then diluted with 10 cc of sterile 0.9 per cent sodium chloride solution well mixed and centrifuged. The supernatant fluid is decanted and the residue seeded on the surface of the crystal violet potato medium the culture tube being capped with tin foil after the cotton plug has been impregnated lightly with hot paraffin.

The medium is prepared by cutting large clean peeled potatoes into cylinders about 3 inches long and  $\frac{5}{8}$  inch in diameter. The cylinders are halved longitudinally and soaked in 1 per cent sodium carbonate solution containing 1:75,000 crystal violet (the dye and sodium carbonate being mixed just prior to use) for from 1 to 2 hours. The cylinders are then wiped off with a clean towel and introduced into a sterile culture tube containing 1.5 cc of 5 per cent glycerol broth. The tube is plugged with cotton and sterilized in an autoclave at 15 pounds pressure for at least 30 minutes.

After incubation on this medium for from 2 to 6 weeks a luxuriant elevated growth of tubercle bacilli becomes visible when positive.

### G ANIMAL INOCULATION TESTS

**Guinea-pig Test for Tuberculosis** The inoculation of urine into guinea pigs is a valuable and commonly used test for tuberculosis. Its chief drawback lies in the fact that a month or more must often elapse before the diagnosis can be made.

**Technic** Two guinea pigs which have been proved free from tuberculosis by application of the tuberculin reaction, are inoculated with the urinary sediment, the injection being made directly into the inguinal lymph nodes in the first animal and intraperitoneally in the second. If, after an observation period of 22 days the animals have neither de-

creased in weight nor manifested any clinical evidences of disease, they may be regarded as offering negative evidence

If neither guinea pig dies during this observation period, it is well to retain them under observation for an additional 3 weeks

If a glandular development suggestive of tuberculous nodules appears, the nodules are removed and subjected to histologic section. If the animals lose weight, they are asphyxiated by gas and a thorough post mortem search made for evidence of tuberculosis. An autopsy is also performed if the guinea pig dies before expiration of the 3 weeks

When the injected urine is positive for tubercle bacilli, the peritoneal cavity will usually be found studded with tuberculous nodules. Death may be due to other causes, such as pneumonia. If so the injection must be repeated before a report can be rendered

**Aschheim-Zondek Test for Early Pregnancy** The Aschheim Zondek test for early pregnancy depends upon the demonstration of certain substances in the urine which, when injected into immature mice or rabbits, produce characteristic chemical changes in the ovaries. The exact nature of these substances is unknown. It was formerly believed that only the secretion from the anterior lobe of the pituitary gland was involved, but it is now recognized that other parts of the female sex organs may contribute as well. The hormone responsible for the development of mature follicles and the formation of hemorrhagic cysts is called Prolan A, while that producing corpora lutea and ovulation is called Prolan B.

The test has its basis in the fact that there is a tremendous over production of anterior pituitary lobe hormone as soon as pregnancy is established. There is also a rapid excretion of this hormone into the urine during the early days of pregnancy, due to increased permeability of the kidneys. The anterior lobe product can easily be detected a few days after the first skipped menstrual period.

*Method of Obtaining the Reaction* The subcutaneous injection of the urine of a pregnant woman into immature female mice or rabbits brings about swelling, congestion, hemorrhage, and rapid maturity of the ovarian follicles. These changes are so marked that they are visible to the naked eye if autopsy is done upon the animal within 100 hours after injection of the urine.

The urine first voided in the morning has been found richest in hormone and should therefore be used for the test. Always make certain that the patient has not taken any drugs, such as iron, arsenic, or ergot

All of these are freely excreted in the urine and will kill the mice before the reaction in the ovaries has had time to take place.

**The Hormonal Test for Tumor of the Testis.** The Aschheim-Zondek test has proved valuable in the diagnosis and differential diagnosis of testicular tumors, the test being positive in a large percentage of cases. The test has its basis in the fact that Prolan A, the same hormone which appears in the urine of pregnant women, is often liberated in the urine of men with testicular neoplasms, the amount excreted being dependent upon the type of tumor present (Tumors of the Testicle The Hormonal Test, p 459). A positive Aschheim-Zondek reaction is of the greatest diagnostic assistance. A negative reaction is of less value, for testicular neoplasms have been recognized clinically in the presence of a negative response to the test.

**Method of Obtaining the Reaction.** The urine of a patient suspected of having a malignant tumor of the testis is injected into a female mouse and an autopsy performed upon the mouse 4 days later. If the hormone is present, there will be swelling and congestion of the ovaries and hemorrhage. Urine specimens should be the first specimen voided in the morning, should be about 100 cc in amount, and should contain no preservative.

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## CHAPTER III

### TESTS OF RENAL FUNCTION

Ascertaining the functional efficiency of the kidneys especially of one kidney when removal of the other is contemplated is a most important part of urological diagnosis. In spite of their definite limitations renal function tests are invaluable to the urological diagnostician. They are utilized in two ways (1) to determine the total amount of work done by both kidneys (total renal function) (2) to ascertain the relative ability of each kidney in the performance of the total amount of work (relative renal function). There are many such tests but they all fall into one of three groups (1) tests of excretion (2) tests of retention (3) combined tests of excretion and retention.

There are three major ways of investigating renal function (1) by measuring the elimination of dyes injected for the purpose of coloring the urine, (2) by estimating the total nitrogenous output in the urine particularly urea (3) by tests of blood chemistry to determine whether elements which should be eliminated in the urine are being retained in the blood thus indicating the inability of the kidneys to carry on their proper function.

#### A TESTS OF EXCRETION

##### *The Dye Tests*

**The Phenolsulphonphthalein Test** The phenolsulphonphthalein or 'phthalein test' as it is more conveniently called is the most popular of all the renal function tests. It was introduced in 1910 by Rowntree and Geraghty, of The Johns Hopkins University and is one of the most important contributions by Americans to urology. Phenolsulphonphthalein has the advantage of being non-irritating, non-toxic and easily used and the test determines the activity of elimination with mathematical accuracy. From 60 to 85 per cent of the amount injected is excreted by the normal kidney in two hours. The percentage is very simply determined by the use of the colorimeter.

The phthalein test may be either *total* or *divided*, according to whether the entire output of colored urine is collected or the output of each kidney separately by means of ureteral catheters

*Divided Test* After the patient has emptied his bladder, he is given 400 cc of water. Cystoscopy is done and ureteral catheters inserted. One cc (0.006 Gm) of a sterile solution of phenolsulphonphthalein is injected either intravenously or (rarely) into the muscles of the arm. Normally, the dye begins to be excreted in from 2 to 6 minutes after intravenous administration and in from 5 to 10 minutes after intramuscular injection, and almost all of it is excreted by the kidneys within 2 hours.

As the urine is secreted, it flows out through the catheters and drops into test tubes containing a little sodium hydroxide, 10 per cent. When the alkalinized urine turns reddish, excretion of the dye has begun. The precise moment and the side on which it first appears should be noted, and the appearance time marked on the label of each tube. In our practice, the dye is always injected intravenously and specimens are collected from both sides 10 minutes after the initial appearance of the dye, during which period from 18 to 20 per cent of the drug should be excreted if conditions are normal. If desired, specimens may be collected at the end of the first and second hours. Normally, 40 to 60 per cent of the drug is excreted during the first hour and 80 to 85 per cent over a two-hour period. When this proportion is altered, even though the total output of the two-hour period is normal, it gives evidence of renal impairment, especially when the output of the second hour exceeds that of the first.

The amount of dye excreted does not correspond to the volume of the urine. Even though the quantity of liquid be normal, the permeability of the drug may be much diminished in proportion to the intensity of the renal damage. Though uremia may be impending in nephritis or in the puerperal state, the liquid output may still remain normal in volume.

*The presence of the catheters in the ureters may cause retention of urine by the kidneys and there may be delay in the appearance of the color on this account.* This factor must always be considered, but the total output of each kidney is the important point rather than the appearance time.

*Total Test* In the total phthalein test the patient is given 400 cc of water, the bladder emptied 9 minutes later, and 1 cc of phenol sulphonphthalein injected intravenously or (rarely) intramuscularly.

Following intravenous administration specimens are collected as follows

- First specimen—20 minutes after injection of dye
- Second specimen—35 minutes after injection of dye
- Third specimen—60 minutes after injection of dye
- Fourth specimen—125 minutes after injection of dye

Following intramuscular injection, specimens are collected in our practice as follows (the patient being given 200 cc of water at the time each specimen is collected),

- First specimen—40 minutes after injection of the dye
- Second specimen—30 minutes later
- Third specimen—30 minutes later
- Fourth specimen—30 minutes later
- Fifth specimen—60 minutes later

*Measuring Output of Phenolsulphonphthalein* The actual output of phenolsulphonphthalein is measured with a Hellige or Duboscq colorimeter, or with the convenient and inexpensive Dunning colorimeter made for this purpose. This is a series of tubes containing carefully estimated dilutions of phenolsulphonphthalein. The urine specimens are diluted on the basis of 1 cc of phenolsulphonphthalein to 1 000 cc of water. Since the return is usually too slight to make this dilution practical the specimen of urine is diluted to 50 or 100 cc and the result then divided by 20 or 10 as the case may be. The specimens are then compared with the contents of the colorimeter tubes and the excretion of dye measured thereby. An even more exact but more expensive apparatus is that known as the Young Elvers phthaleinometer. This has the standard dilutions arranged in tubes on the edge of a disc that can be rotated so as to bring each dilution in turn close to the tube containing the phthaleinized urine to be compared.

**Methylene-blue Test** In this test of Achard and Castaigne a solution of methylene blue is injected intramuscularly and the time of its appearance in the urine noted. Normally it should appear in about 30 minutes but when delayed renal permeability is supposed to have been interfered with

Since methylene blue is sometimes excreted as a colorless derivative, the use of indigo-carmine in this test has been proposed as a substitute.

**Indigo-carmine Test** This dye test originated by Voelcker and Joseph is less generally used than the phenolsulphonphthalein test but is preferable in some renal conditions. It is most useful in connection with cystoscopic inspection of the bladder. When the bladder is greatly

inflamed, as in urinary tuberculosis, it is sometimes impossible to locate the ureteral orifices. By watching for the jets of blue urine, one is enabled to locate an otherwise invisible opening. Again, when one kidney is believed to be functionless, but both ureters are in such a condition that catheterization is unwise or impossible, the side of the still functioning kidney may be determined by noting the appearance of the blue urine in the bladder.

This test is inaccurate for determining the function of a kidney, due to the fact that a large portion of normal kidney tissue may surround the pelvis, secreting at once a considerable dye when the rest of the kidney may be destroyed.

*Technic* Four cc. of a 4 per cent solution of the dye is injected intravenously or into the thigh. Following intravenous injection the urine should show blue coloration within 3 to 5 minutes, if injected intramuscularly, it should appear within 10 to 15 minutes. The excretion of the dye may continue long after its initial appearance. However, complete estimations are not now made by this test, the phthalein method being preferred for this purpose.

#### *Phloridzin Test (Von Mehring)*

This test consists in the hypodermic injection of a small quantity of phloridzin. In health, this substance is transformed into glucose by the kidneys. In disease this change is more or less interfered with, and the amount of glucose recoverable from the urine is taken as an index of the secretory power of the kidneys.

#### *Mosenthal Diet Test for Renal Function*

This test was originally suggested by Hedinger and Schlayer in 1914 and later elaborated by Mosenthal.

The urine is collected during the day at two hour intervals, the patient partaking of his ordinary diet in the usual amount but *taking neither food nor fluid between meals*. The bladder should be completely evacuated every 2 hours, and the specimens kept in separate bottles, properly labeled with the time of voiding.

A time schedule should be given to the patient. For example, he should be directed to collect the specimens at 8 and 10 a.m., noon, 2, 4, and 6 p.m., and 3 hours after the evening meal. Any urine passed later during the night should be kept and added to the specimen voided in the morning which thus would represent the output of 10 or 12 hours.

Under these circumstances the normal response should show a maxi

imum specific gravity of 1.018 or more. The specific gravity should vary at least 9 points between the highest and the lowest readings. The night urine should be small in amount (less than 400 cc.) and of high specific gravity (1.018 or over).

Signs of diminished renal function are (1) a lowering of the maximal specific gravity (2) a fixation of the specific gravity (3) a nocturnal polyuria.

This test is easily employed and is of especial value in early cases of nephritis.

### *Experimental Polyuria Test (Albarran)*

This test consists essentially in taking specimens of urine from each kidney while the patient is thirsty and after comparison of the two specimens having the patient drink a large quantity of water the effect upon renal activity then being noted.

The basic factors of the test are (1) The function of a diseased kidney is more uniform than that of a healthy organ and the greater the destruction of its parenchyma the less will its functional ability vary on different occasions (2) If but one kidney is diseased or if it is more diseased than the other when urinary activity is disturbed the more diseased organ will show less functional disturbance than the sound or relatively sound one. Thus when large quantities of water are ingested a separate examination of the urine of each kidney will show that the sound or less diseased kidney is doing more work and is excreting a larger total amount of fluid and solids although the actual percentage of solids will be diminished. The function of the diseased kidney will on the contrary be little if at all affected.

*Technic* The patient must abstain from food and liquids for at least 3 hours prior to commencement of the test. The urine is thereafter collected from each kidney for one half hour and saved for comparison with the specimens taken after the ingestion of fluid. At the end of the half hour 600 cc. of mineral water is drunk by the patient after which separate specimens are again collected and compared with the first specimens. The catheters are left in and the urine collected for a period of one and a half hours.

The total amount of urine passed should be noted the total quantity and concentration of urea and sodium chloride estimated the freezing point obtained and if phloridzin has been given the amount of sugar estimated.

Normally polyuria appears within the first half hour reaches its

maximum during the third half hour, and then rapidly declines. The total amount of solids remains constant or increases, but the percentage decreases in proportion to the polyuria.

If renal activity is impaired, polyuria will be absent or delayed and the solid constant unaffected.

### *Tests for Output of Urea Nitrogen*

Urea is the chief solid constituent of the urine, as well as the most important, both physiologically and pathologically. Its nitrogenous character is indicated by its chemical formula, which is  $\text{CO}(\text{NH}_2)_2$ . Urea forms 80 to 90 per cent of the total nitrogenous output of the kidneys. The other nitrogenous constituents are ammonia, creatinine, and uric acid. The output of urea varies markedly with the fluids as well as the diet.

**Quantitative Estimation (Sodium Hypobromite Method).** The method most commonly employed for the quantitative estimation of urea is the sodium hypobromite method. It depends upon the fact that urea decomposes under the action of sodium hypobromite, with liberation of nitrogen, and from the volume of nitrogen thus set free the amount of urea can be calculated. The Doremus-Hinds ureometer is commonly used for this purpose.

After rinsing out the larger tube of the apparatus with water, fill it and the bulb with a 25 per cent solution of caustic soda. Add to this, by means of a medicine dropper, 1 cc. of bromine and mix well. This prepares a fresh solution of sodium bromide with excess of caustic soda, which serves to absorb the carbon dioxide set free in the decomposition of the urea. (When handling bromine, keep an open vessel of ammonia near, to neutralize the effect of the irritant fumes.)

Pour the urine into the smaller tube, and then turn the stop-cock so as to let as much urine as desired (usually 1 cc.) run slowly into the hypobromite solution. When bubbles have ceased to rise, read off the height of the fluid in the large tube by the gradations upon its sides. This gives the amount of weight of urea in the urine which has been added, from which the amount excreted in 24 hours can easily be calculated. If the urine contains much more urea than the normal amount, it should be diluted.

To avoid handling pure bromine, Rice's solution may be used:

(1)		(2)	
Bromine	31 gm	Caustic soda	100 gm
Potassium bromide	31 gm	Distilled water	250 cc

One part of each of these solutions and 2 parts of water are mixed and used for the test. The bromine solution must be kept in a tightly stoppered bottle otherwise it will lose its strength very quickly.

**Urease Method (Marshall)** An even more accurate test for urea is that devised by Professor Eli Kennerly Marshall Jr., of The Johns Hopkins University. In this test, the urea is changed into ammonium carbonate by the enzyme urease and the ammonia titrated with one tenth normal hydrochloric acid, using methyl orange as an indicator.

### *Urine Concentration Test*

The methods of performing this test, which is designed to show the ability of the kidneys to concentrate urine, vary considerably. In general, the test is begun with an empty bladder and fluids are withheld during the entire examination, which usually extends over a period of 16 to 24 hours.

**Technic** Supper the evening before the test should contain not more than 200 cc of fluid. Nothing is permitted by mouth from 6 00 p m until 10 00 a m. The patient voids before retiring, and this specimen is discarded. Urine specimens are collected at 6 00, 8 00, and 10 00 a m. The time of collection of each specimen is recorded in hours after 6 00 p m—i.e., the 8 00 a m specimen is 14 hours. Each specimen is examined for volume and specific gravity.

Normal kidneys concentrate to 1 020—as a rule, to 1 025.

### *Urine Dilution Test*

The urine dilution test is designed to measure the power of the kidneys to dilute urine.

**Technic** Keep the patient in bed and withhold breakfast until after the test is completed. At 7 00 a m the patient voids and the specimen is discarded. A half hour later he drinks a large amount of water (1,200 cc). No further fluids are allowed. Urine specimens are collected, and the time recorded, at hour intervals for 4 hours after the first voiding, and examined for volume and specific gravity.

Normal kidneys will excrete the entire amount (1,200 cc) in 4 hours. The specific gravity of one specimen should fall to 1 002.

## **B TESTS OF RETENTION**

**Relation of Blood Chemistry to Urinalysis** Urinalysis has for its principle object the determination of what the kidneys are *excreting*



Blood chemistry tests, on the other hand, are concerned with substances which the kidneys have *retained*. They therefore complement the investigations upon the urine, and in many instances are of even greater assistance to the urologist in determining the extent of renal dysfunction than are the older tests of the products of excretion. In the diseases with which he is primarily concerned the retained products of metabolism are usually the determining factors.

Although analysis of the blood for diagnostic purposes is a procedure of many years' standing, it is only recently that the microchemical colorimetric methods employed in urinalysis have been applied to blood chemistry. The older methods were unstandardized and the results of one investigator not readily compared with those of another. The introduction of microchemical methods made possible the correlation of findings from different sources. The individual examiner was enabled readily to determine the nitrogenous contents of the blood (urea, creatine, creatinine, etc.) just as had been previously done for the urine—as well as the blood proteins. Other tests can now be used to determine blood sugar (Galatest) and calcium (Lyman's), and there are also available microchemical methods such as Bloor's for cholesterol, fats, and lecithin.

The chemical determination of the blood constituents has been made practical even for those who do not have ready access to professional laboratories, and to the urologist, in particular, its usefulness is such that blood estimations should be made a routine of examination. While examination of the blood in no wise replaces urinalysis as an aid to diagnosis and a practical guide to treatment the blood findings are of the greatest value, and the utilization of both urinalysis and blood chemistry tests will ordinarily prove of far greater assistance to the examiner than the employment of either measure alone.

The first blood test employed in urological work, and the one which still remains the most useful, is that for urea nitrogen. Of almost equal value are the tests for non protein nitrogen, creatinine, chloride, uric acid, and carbon dioxide combining power. The determination of blood sugar is also of value as indicating diabetic tendencies in urological patients although hyperglycemia is an almost universal accompaniment of nitrogen retention. If high nitrogen and sugar values are demonstrated, the measuring of carbon dioxide combining power becomes urgent.

**Importance of Blood Findings in Urological Conditions** *Prostatic Hypertrophy* It is in cases of prostatic hypertrophy, with extensive

of the damage suffered by the kidneys. In cases where no definite findings indicate renal disease but a suspicion of it exists, blood chemistry will usually clear up the uncertainty, or, if the existence of renal disease has already been established, the behavior of the urinary system, after treatment has been undertaken, can be more satisfactorily watched and checked in this way than by any other method.

If but one kidney is affected, blood chemistry will not be of great service to the surgeon in making his decisions in regard to operation. Often when *nephrectomy* has been performed, the remaining kidney will carry on the work of both sides so effectually as to give normal urea and non-protein nitrogen findings.

The blood findings may likewise be misleading in such conditions as renal tuberculosis and calculous disease of the kidney. Sometimes an increase in the nitrogenous waste-products in these cases may suggest the presence of bilateral involvement, but again, the blood findings may be quite normal even though one kidney has been completely incapacitated, its fellow having been able to carry on the work of both sides successfully. Under such circumstances, renal function tests, such as the phenolsulphonphthalein or the indigo-carmin test, are of far greater service than blood examination.

*Cysts and Tumors* Urea nitrogen is generally but slightly elevated in cases of vesical tumor, either benign or malignant. Where such tumors have induced considerable urinary obstruction, the findings may be similar to those in *prostatic conditions*. Here, also, the demonstration of urea nitrogen amounting to more than 30 mgm per 100 cc of blood contraindicates operative procedures.

In renal cysts—polycystic kidney in particular—urea-nitrogen retention will usually be found to be considerable, approximating that seen in *interstitial nephritis*. The figures for creatinine retention will always be high, relative to those for urea retention. In polycystic kidney, puncture of the cysts may result in a marked lowering of the figures for both urea and creatinine, so that it would not do to say that *all* operative procedures are inadvisable in these cases.

*Normal Values of Blood Constituents* The following are the normal values of the more important constituents of the blood for which tests are often made.

Urea nitrogen	12-15 mgm per 100 cc blood
Non-protein nitrogen	25-35 mgm per 100 cc blood
Creatinine	1-2.5 mgm per 100 cc blood

Uric acid	2-3.5 mgm per 100 cc blood
Creatine	5-8 mgm per 100 cc blood
Sugar	90-120 mgm per 100 cc blood
Serum chlorides	450-500 mgm per 100 cc blood
Plasma chlorides	570-820 mgm per 100 cc blood
Serum calcium	9.5-11 mgm per 100 cc blood
Serum phosphorus	2.5-3.5 mgm per 100 cc blood
Carbon-dioxide combining power	55-75 cc. per 100 cc plasma

### *Tests for Blood Urea Nitrogen*

Urea nitrogen is largely excreted by the kidneys, its normal relation to non-protein nitrogen being about 50 per cent. The normal concentration in the blood is 12 to 15 mgm per 100 cc of blood. Higher values indicate impairment of kidney function. If this is due to a removable obstruction, such as an enlarged prostate or a stone, the high concentration of urea in the blood is not necessarily indicative of a fatal termination since removal of the obstruction will often restore normal, or nearly normal, function. If, however, the high blood urea is due to extensive and irreparable bilateral destruction of renal tissue, it is of the gravest significance. Also, being of endogenous origin, urea nitrogen is likely to show considerable variation in accordance with variations in diet.

**Urease Method.** (1) For the benefit of those to whom laboratory assistance is not readily available, the most frequently employed method of testing for blood urea nitrogen is given.

In a test-tube of 50 cc capacity place 1 cc of a 5 per cent jack bean urease solution (prepared by the Van Slyke formula and purchasable on the market). If activating phosphate solution is not included, 2 drops of this must be added. Two cc of oxalated blood is next added and the whole incubated in a beaker of water at 50°C for 15 minutes. At the expiration of this period, 1 to 2 cc of amyl alcohol, or 4 to 5 drops of pure caprylic alcohol, followed by 4 to 5 cc of saturated sodium carbonate, is added, the test-tube at once inserted in the ungraduated cylinder of the aeration apparatus, the stopper replaced, and the whole aerated for a half hour, the air current being slow at first but later as rapid as the apparatus can stand.

(2) A slight variation of this procedure is to place 1 cc of oxalated blood in a large test tube, add 8 to 10 drops of caprylic alcohol (to prevent bubbling) and a piece of filter paper about 2 cm square, previously impregnated with urease. The tube is then corked and allowed to stand at room temperature for a half hour so as to permit the ferment of the urease to digest the urea. Into a second similar test-

tube put 15 cc of a N/100 solution of HCl, 6 to 8 drops of caprylic alcohol, and 1 drop of a 0.4 per cent alcohol solution of methyl red (to act as an indicator). The two test tubes are then adjusted by suitable tubing of small bore so that a continuous current of air may be bubbled through the blood, going over from this to pass through the acid solution. Just before this union of the tubes is effected, 5 to 10 cc of a saturated solution of  $K_2CO_3$  is added to the first tube, thus liberating the ammonia derived from the action of the urease on the urea. The tube is then quickly closed and the air current allowed to pass for 30 minutes—slowly for 10 minutes, rapidly thereafter. The special aerating apparatus will, of course, be preferable if it can be obtained. During aerating, the ammonia content is taken up by the N/100 HCl solution, and the amount thus neutralized is determined at the end of the process by titrating against a similar N/100 solution of NaOH. The quantity of HCl thus determined, multiplied by 14, gives the amount of urea nitrogen in milligrams per 100 cc of blood.

(3) Still another variation consists in digesting the blood in the usual way, then diluting, 1 to 10, with water and the precipitation agents. After filtration, 5 cc of diluted Nessler's solution is added to the 5 cc of filtrate (equivalent to 0.5 cc of blood), and color comparison made as follows: after incubation of the tube, add 13 or 14 cc of water and 2 cc of a 10 per cent sodium tungstate solution and, while rotating the tube, 2 cc of  $\frac{2}{3}$  N sulphuric acid. Shake vigorously. When blood is properly coagulated, the color of the coagulum turns from pink to dark brown. Failure to do this indicates that coagulation is incomplete probably because too much oxalate has been used. The addition of 5 per cent sulphuric acid, a drop at a time, shaking between each drop should bring about coagulation. Filter carefully through a double portion of filter paper. Into the left hand tube of the colorimeter pipet 5 cc of ammonium sulphate or ammonium chloride solution, containing 0.1 mgm of nitrogen. Dilute with distilled water 2 or 3 cc of modified Nessler's solution (about 5 times) until the volume reaches the 10 cc mark. If 0.5 mgm to 100 cc dilution is desired dilute to 20 cc with distilled water. Simultaneously with the addition of the Nessler's solution to the standard, 5 cc of the blood filtrate should be pipetted into the right hand tube of the instrument, to which is added 3 or 4 cc of the diluted Nessler's solution. The solution should be perfectly clear. Dilution is now made with distilled water, inverting after each addition, until the depth of color is identical with the standard (1 or 0.5 mgm to 100).

*Calculation* In the following formula  $S$  represents the standard and  $R$  the dilution of the unknown  $S/100 \times R \times 200 =$  milligrams of urea N per 100 cc of blood With the 0.5 mgm standard and a dilution of 15 cc for the unknown (multiplying by 200 to obtain the milligrams of urea nitrogen per 100 cc of blood—5 cc of the filtrate being equivalent to 0.5 cc of blood), the result would be  $0.5/100 \times 15 \times 200 = 15$  mgm of urea N, that is, the dilution of the unknown gives the milligrams of urea nitrogen directly

### *Tests for Non Protein Nitrogen*

By non protein nitrogen is indicated the nitrogen constituents of the blood which remain after the proteins have been precipitated, namely, that present in creatinine, urea, uric acid, and various other components As the excretion of non protein nitrogen is carried on largely by the kidneys, any marked increase of these substances in the blood indicates impaired renal efficiency, although it must be borne in mind that a high protein diet may be partly responsible for such an increase and that an alteration in dietary habits will not be immediately appreciable in a reduction of the values determined in the blood In general, it may be assumed that high non protein nitrogen values indicate extensive renal damage

The relation existing between nephritis of various types and the non protein nitrogen retention demonstrable in the blood is dependent upon that existing between the amount of functioning kidney tissue and the volume of work it is called upon to do In chronic nephritis, where albumin and casts are abundant in the urine, or where the condition has advanced to the edematous stage, there is sometimes no increase in non protein nitrogen Because of the likelihood of rapid changes, frequent urinalyses and blood determinations are imperative The greatest non-protein nitrogen retention is found in uremia, yet there is no relation between the degree of such retention and the tendency to develop uremia

The estimation of non protein nitrogen is considerably more complicated than that of urea nitrogen, and for this reason the latter test is much more widely used in urology, where a large number of examinations are required Since urea nitrogen and non protein nitrogen figures generally parallel each other, and are regarded as having the same significance, the test for the latter is usually not made unless the urea nitrogen is elevated above 40 mgm per 100 cc of blood Those who have the equipment at hand will be able to avail themselves of standard formulas for making the determinations, and their presentation here is unnecessary

*Tests for Creatinine*

In the later stages of nephritis the creatinine content of the blood is markedly increased. In general, it may be stated that the excretion of this substance is decreased in any pathological condition associated with wasting of the muscles, and increases in proportion to the return to normal catabolism. As creatinine is known to be of endogenous origin, its determination will give a very fair idea of the stage to which the disease has advanced. The creatinine values must, however, always be considered in relation to the blood urea findings. Creatinine in the blood is noticeably increased only when the blood urea nitrogen figures have undergone a 100 per cent increase, creatinine estimations are not, therefore, usually carried out unless the blood urea nitrogen exceeds 40 mgm per 100 cc of blood. Myers and Killian noted that in cases where creatinine rose above 5 mgm per 100 cc of blood there was rarely a subsequent improvement, all such patients dying within a short time, but even if urea retention were marked, given a relatively low creatinine figure—well below 5 mgm per 100 cc of blood—a fair chance for recovery could be predicted. It is the opinion of these authors that in advanced nephritis blood creatinine estimation is the most reliable prognostic maneuver we possess.

*Tests for Serum Calcium, Inorganic Phosphorus, and Phosphatase*

The normal serum calcium is 9.5 to 11 mgm per 100 cc of blood, the normal inorganic phosphorus, 2.5 to 3.5 mgm per 100 cc of blood. This calcium phosphorus balance is controlled by the parathyroid glands. In tumor of the parathyroids there will be a disturbance of the normal calcium phosphorus equilibrium, evidenced by a high blood serum calcium and a low blood serum phosphorus. With the fall in inorganic phosphorus, there will be a rise in phosphatase—the enzyme which liberates inorganic phosphorus from organic phosphorus. The increased calcium which the kidneys must remove from the blood frequently results in a precipitation of calcium phosphates in the urine, with chronic stone formation.

Surgical removal of the parathyroid tumor will restore the output of parathyroid secretion to its normal amount, resulting in a reduction of the blood calcium and phosphorus, which, in turn, will reduce the excretion of these elements in the urine. In cases of multiple urinary calculi or chronic stone formation, these tests are of great importance since one may thereby determine whether the lithiasis is due to hyperparathyroidism.

When calcium, phosphorus, and phosphatase determinations are desired from one specimen, it is necessary that two full Wassermann tubes (about 15 cc) of coagulated blood be sent to the laboratory. Phosphatase determinations are reported in terms of units each of which represents sufficient phosphatase to form from glycerophosphate 1 mgm of inorganic phosphorus per 100 cc of blood per hour. The normal is 1.5 to 4 units.

### *Measuring Carbon-Dioxide Combining Power of the Blood*

The normal carbon dioxide combining power of the blood is 55 to 75 cc per 100 cc of plasma. A low percentage indicates a disturbance of the acid alkali equilibrium, namely a lowering of the base, producing the symptom complex known as 'acidosis'. The kidneys play an important part in the separation of acids from the blood to maintain this acid base neutrality. In diabetes, acidosis may occur irrespective of renal sufficiency. Frequently, however, acidosis occurs secondary to renal insufficiency, and in these cases a blood carbon dioxide test gives valuable information regarding the eliminatory capacity of the kidneys.

If high nitrogen and blood sugar values are demonstrated, the measuring of carbon dioxide combining power becomes urgent. Many urologists now make repeated blood carbon dioxide examinations routinely in cases of urinary infection or stone when the patient is given large amounts of urine acidifying drugs or is kept on an acid ash or a ketogenic diet over a considerable period of time.

### *Securing Blood for Blood Chemistry Examination*

The veins usually used for obtaining blood samples are the median cephalic and basilic, at the bend of the elbow. It is preferable that the blood be taken when the patient is fasting, therefore, the specimen is usually drawn before breakfast, the patient abstaining from all fruit and fruit juices after midnight.

The amount of blood required for the tests varies. For creatinine and serum calcium estimations 10 cc of blood is required for each examination, for calcium, inorganic phosphorus and phosphatase determinations on one specimen, 15 to 16 cc, for blood sugar, 3 cc, for all other tests, about 5 cc. Blood for sugar and urea tests is put into tubes containing a small amount of sodium oxalate, which is well mixed with the blood to prevent clotting. Specimens for blood carbon dioxide examination should be taken under oil in special tubes, and the small tube left in the large tube when sending the specimen to the laboratory.

## C. COMBINED TESTS OF EXCRETION AND RETENTION

*Ambard's and McLean's Coefficients*

Ambard claims to have shown that the elimination of certain substances is carried on by the kidneys according to definite laws which are capable of mathematical expression. These laws he reduced to a mathematical formula known as Ambard's coefficient.

The constant ratio between the concentration of urea in the blood and the rate of excretion in the urine is determined by the following mathematical formula:

$$\text{Constant (K)} = \sqrt{D \times \frac{70}{Wt} \times \sqrt{\frac{C}{25}}}$$

Ur = Grams of urea per liter of blood

D = Grams of urea excreted per 24 hours.

Wt = Weight of individual in kilograms.

C = Grams of urea per liter of urine

The standard concentration of urea in the urine is assumed to be 25 gm per liter and the standard weight 70 kgm. The normal value of the coefficient is between 0.07 and 0.09. If renal function is impaired, and the kidney unable to eliminate in proportion to the concentration of urea in the blood, there will be a rise in the constant in proportion to the degree of renal insufficiency. Values of from 0.09 to 0.12 indicate slight renal impairment, 0.13 to 0.2 indicate moderate impairment, and above 0.2 severe impairment.

*McLean's modification* provides an index which directly expresses the changes in the rate of excretion. One hundred represents the normal finding and corresponds with a value of 0.08 for Ambard's coefficient. In this country McLean's index is now more widely used than Ambard's coefficient. It is expressed as follows:

$$\text{Index} = \frac{\text{gm. urea per 24 hours} \times \sqrt{\text{gm. urea per liter of urine} \times 8.96}}{\text{Wt. in kgm.} \times (\text{gm. urea per liter of blood})}$$

*Technic* The patient is weighed and given 150 to 200 cc of water, to secure free excretion of urine. One half hour later the bladder is emptied completely, by catheter if necessary. The time of evacuation is noted exactly. The urine is collected at the end of 72 minutes, i.e., one twentieth of 24 hours. Thirty six minutes after the beginning of the period, 10 cc of blood is obtained from the vein of the arm, clotting



being prevented by the addition of sodium or potassium oxalate, and the amount of urea determined. The patient must take neither food nor water during the 72 minute period. If any urine is voided during the interval, it must be added to that obtained at the end of the period. All urine must be scrupulously preserved and the total quantity accurately measured.

*The procedure for determining blood urea* is given by Van Slyke and Cullen as follows. Run 3 cc. of oxalated blood into a large test tube containing about 10 cc. ammonia free distilled water. Add 2 urease tablets (powdered). Leave at room temperature for 30 minutes. Add a teaspoonful of salt, a few drops of foam killer (20 per cent solution of rosin in turpentine), and finally 5 cc. of a saturated solution of potassium carbonate. Drive off the ammonia by aspiration into another tube, containing 15 cc. N/100 sulphuric acid and 1 drop of alizarin. Titrate the excess of acid with N/100 sodium hydroxide.

Each cubic centimeter of acid neutralized indicates 10 mgm. of urea per 100 cc. of blood or 4.67 mgm. of urea nitrogen per 100 cc. of blood. In case the blood is one of the rare samples containing over 150 mgm. of urea per 100 cc., all the acid will be neutralized and it will be necessary to repeat the determination, using only 1 cc. of blood. Fresh blood contains so little ammonia that it may be disregarded. The figures obtained for urea nitrogen may be converted into urea by dividing by the factor 0.467.

The amount of urea nitrogen found in normal blood is 12 to 15 mgm. per 100 cc.

The following data are now available: the quantity of urine passed in 72 minutes multiplied by 20 to give the 24-hour amount, the grams of urea per liter of urine, from which may be determined the amount in 24 hours, the grams of urea per liter of blood, and the patient's weight in kilograms. These figures are substituted in the formula.

McLean has shown that these findings correspond closely with those of the phenolsulphonphthalein test. While 100 is taken as representing normal, he states that the index is usually between 100 and 200, variations between 80 and 300 being not infrequent in normal persons, that an index below 80 is to be considered abnormal, though not necessarily seriously so, and that in renal disease an index below 50 indicates a considerable degree of renal dysfunction. He believes that the amount of damage to the kidney is increasingly greater as the index is lower and tends to approach zero.

*Urea Clearance Test*

The work of Van Slyke and numerous other investigators has demonstrated that when the volume of urine excreted is fairly large there is a direct proportion between the amount of urea in the blood and the rate at which the kidneys excrete urea. Expressed another way—the urine being abundant, the per minute excretion of urea is equal to the amount of urea to be found in a constant volume of blood. This “blood constant” has been figured to be, in an adult of normal size, about 75 cc. Note, however, that the volume of urine must be ‘fairly large’ that is the direct ratio between the blood urea content and urea excretion by the kidneys holds good only when the amount being excreted is above a certain limit. This limit, which in adults is about 2 cc per minute, has been called by Van Slyke and his collaborators the “augmentation limit.” These observers noted that when the volume of urine was less than the augmentation limit of the individual whose excretion was being studied, there was a proportionate fall in the urea excretion rate. Taking an average if the blood urea remaining constant, the volume of urine were diminished to one fourth (from 2 to 0.5 cc per minute) the urea excretion rate would be cut in half.

When the urine volume output rises above the augmentation limit at any given point the excretion of urea will go on at a maximum rate. Therefore the urea content of a maximum volume of blood will be represented by the output. In normal men as we have already seen, this blood volume is about 75 cc per minute. This is known as the *maximum blood urea clearance* a term usually shortened to simply *maximum clearance*.

By “maximum clearance” we mean the volume of blood which one minute’s excretion suffices to clear of urea when the urine volume is large enough to permit a *maximum* urea output.

The value of the maximum clearance ( $C_m$ ) is calculated from the observed urea concentration of the blood (B) and urine (U) and the urine volume (V) in cubic centimeters per minute, using the following formula. Maximum blood urea clearance =  $C_m = UV/B$ . The concentration ratio  $U/B$  indicates the number of cubic centimeters of blood the urea content of which is represented in 1 cc of urine.  $U/B \times V$  therefore, indicates the number of cubic centimeters of blood represented in the urea content of the V cubic centimeters of urine excreted in one minute.

Below the augmentation limit the volume of blood (the urea content

of which is represented in one minute's excretion—that is, the blood urea clearance per minute) is not constant. On the average, it varies in proportion to the square root of the urine volume. Van Slyke and his co-workers have developed the following formula, by which the urea excretion that would accompany a standard urine volume can be calculated from the excretion measured with any other volume below the augmentation limit. Standard blood urea clearance =  $C_m = U/B\sqrt{V}$

*Standard clearance* indicates the volume of blood cleared of urea per minute by renal action when the volume of urine is at approximately average normal level, that is, 1 cc per minute. Making use of the above formula, the mean normal level of the standard clearance was found to be 54 cc of blood per minute, as compared with the 75 cc *maximum clearance*.

When the organism is affected with disease, both values will vary in approximately the same degree.

**Technic of Urea Clearance Test of Renal Efficiency** The urine is collected in two portions during successive periods of 1 hour each. Blood is drawn at about the middle of the 2 hour interval. The urine volume is determined, if the urine volume is less than 2 cc the *standard clearance* is calculated from the blood and urine urea contents and the urine volume, if the urine volume exceeds 2 cc per minute, the *maximum clearance* is so calculated. In either case, it will be found most convenient to calculate both clearances in terms of percentages of the mean normal values.

**Clinical Applications of the Test** The onset of uremic symptoms bears a definite relation to blood urea clearance. It has been noted in all types of renal disease that whenever the clearance is lowered to 5 per cent of normal, uremia regularly supervenes. However, it is well known that patients who have been demonstrated to have no more than 10 to 15 per cent of normal clearance, will often live comfortably and without any great curtailment of the requirements upon their strength and energy.

The relation of cardiac decompensation and insufficient renal function would seem to rest upon the fact of lessening of the volume of blood passing per minute through the kidneys. In the same way, in glomerular nephritis, the fact that the renal blood vessels have been damaged would again appear to be responsible for renal insufficiency by providing a lessened flow of blood to the kidneys. Van Slyke and his co-workers concluded that in the hemorrhagic or glomerular form of Bright's disease, or in the degenerative form (nephrosis), the destruction of the

glomeruli can be demonstrated to be in proportion to the decrease in blood urea clearance. The more the glomeruli are injured the less able are the kidneys to rid themselves of their burden of urea.

But, on the other hand, the arteriosclerotic type of Bright's disease, in which there is no extensive glomerular damage, will still show a tremendous fall in blood urea clearance, so here this fall in clearance must be due to injury sustained by the renal arterioles.

### *Cryoscopy*

Cryoscopy is the determination of the freezing point of a fluid, usually blood or urine, as compared with the freezing point of distilled water.

**Value in Urology** Cryoscopy has a distinct though limited value in urology. The determination of a lowered freezing point of the urine is regarded as evidence of molecular concentration.

The method devised by Koranyi in 1894 consists in ascertaining the freezing points of the blood and urine of an individual and, by correlating the figures thus obtained, drawing certain deductions regarding the efficiency of that individual's renal function. The introduction of the dye tests turned attention from cryoscopy as a functional test but it still remains a useful diagnostic adjunct.

Determination of the freezing point of a fluid has certain advantages over ascertaining its specific gravity. A much smaller amount of the fluid will serve for cryoscopy than for ascertaining the specific gravity—a great advantage when specimens of urine are difficult to secure. The substances which that fluid holds in suspension influence its specific gravity but not its freezing point. Even if indigo-carmin has been injected, the freezing point of the urine will not be affected.

Cryoscopy is of most value when employed upon urine separately obtained by ureteral catheterization. It affords an estimate of the amount of urinary solids contained in solution in the specimen under examination, that is, it gives us its molecular concentration. If there is dysfunction of one kidney, a comparison of the molecular concentration of both sides will furnish information regarding the ability of the other kidney to carry on the work adequately. The patient must be inhibited from ingesting fluids for at least 6 hours prior to the application of the test, this "desiccation" putting an extra strain upon all functioning renal tissue and compelling the good kidney to show its powers of concentration and whether or not it is able to excrete sufficient urinary solids when the ingestion of fluid is temporarily suspended.

When the urine of a patient is to be subjected to cryoscopy, a sample of the blood should be examined at the same time. The normal freezing point of urine is between  $0.8^{\circ}\text{C}$  and  $2.0^{\circ}\text{C}$ , that of blood, between  $0.56^{\circ}\text{C}$  and  $0.58^{\circ}\text{C}$ . Wide variation from these figures indicates functional disability. Repeated cryoscopic examination of the urine and blood, especially when done in conjunction with bilateral ureteral catheterization, therefore affords a valuable means of determining the presence of renal or cardiac disability.

**Technic** A practical cryoscopy apparatus can be constructed from a large jar and a large sized test tube. These are arranged similarly to the ordinary household ice cream freezer, the jar being filled with ice and salt mixture and the tube inserted in the middle and covered to its extreme top. The urine to be cryoscoped is poured into a smaller test tube, tightly stoppered with a rubber stopper perforated to admit the thermometer and a wire stirring rod. A special thermometer has been devised for this test, its zero point being the freezing point of distilled water. Only a small quantity of urine is needed—just enough to cover the mercury in the thermometer.

After the urine has been poured into the small tube, it is corked and inserted in the larger tube, the purpose being to prevent the tube containing the urine from coming in contact with the freezing mixture, as this may render the readings inexact. The stirring wire should be kept in gentle motion while the freezing is in process. The movements of the mercury column should be watched until they cease—cessation indicating that freezing has been accomplished. The mercury will fall at first, then rise suddenly, and possibly make other excursions before freezing occurs. When it ceases to move, the reading will be the cryoscopic index for that particular specimen of urine.

When the urine from each kidney has been thus tested, a comparison between the two specimens is made, their individual and relative functional ability being thus ascertained.

#### D ERYTHROCYTE SEDIMENTATION TEST COMPARISON OF SEDIMENTATION RATE AND BLOOD CHEMISTRY

This test, though not concerned with renal function, is included here because a comparison of the sedimentation rate and blood chemistry is of considerable importance to the urological diagnostician.

The so called sedimentation test consists in observing the time required for separation of the erythrocytes from the plasma in a given

blood specimen which has been rendered non coagulable and comparing the rate with the normal standard. This test is not specific for any particular disease but is regarded as a peculiarly delicate and accurate indication of the presence of an inflammatory process anywhere in the body. It makes no difference from what part of the body the specimen is secured the separation time is the same whether the sample be secured directly at the site of inflammation or as remote from it as possible.

Though it had long been known that sedimentation is more rapid in disease than in health it was not until 1916—after the practice of citrating the blood to render it more readily transfused had been established—that this fact was used as the basis of a scientific test. Fahraeus, and later Linzenmeier studying the blood of pregnant women and others suffering from gynecological affections such as pyosalpinx noted the increased speed of sedimentation in patients known to harbor inflammatory lesions. By obtaining the average sedimentation time in normal women a diagnostic aid of considerable value was soon set up.

Diseases in which the test has been proved to be of real diagnostic and prognostic value include tuberculosis pneumonia empyema pelvic inflammations acute febrile illnesses acute cholecystitis infectious arthritis and Hodgkin's disease. The test being non specific it must be very carefully interpreted and correlated with other diagnostic factors. A normal sedimentation rate does not preclude the presence of disease since in many diseases the rate is normal. An increased sedimentation rate on the other hand, is a definite indication that disease is present.

Various factors such as the protein content and viscosity of the blood, and the number and size of the red blood cells influence the sedimentation rate.

**Technic.** There are numerous methods of measuring the sedimentation rate now in use. We prefer the Westergren technic as modified by Bannick and others of the Mayo Clinic. This simple test is performed as follows. A tourniquet is applied to the patient's arm and the skin over a prominent vein is disinfected with iodine and alcohol. Five-tenths cc of a 3.8 per cent solution of sodium citrate is drawn into a sterile syringe. The needle is then plunged into the vein and 4.5 cc of blood withdrawn with as little stasis as possible. The syringe is tilted several times to mix the blood and solution. After thorough mixing it is emptied into a glass receptacle such as a watch glass or a flat dish. A 200 mm. Westergren pipet is then filled to mark 0 with the mixture and the pipet placed in a Westergren block in a strictly vertical position at room temperature.

The height of the column of plasma is read at the end of 1 hour and reported in terms of millimeters of sedimentation in 1 hour. Twenty mm. per hour is the upper limit of normal for the rate according to this technic.

**Value of Test in Urinary-tract Diseases.** Although originally applied in gynecological and obstetrical conditions, there is a growing tendency on the part of urologists to utilize the blood sedimentation test as an additional confirmation of a diagnosis arrived at by other means and as an aid in the prognosis of urinary-tract affections. In gonorrheal arthritis, epididymitis, and urethritis, in chronic nephritis, and in the many infectious conditions dependent upon hypertrophy of the prostate, it has been particularly serviceable. Comparison of blood chemistry and sedimentation rate in cases of urinary-tract infection is especially interesting. The blood's uric acid content has long been claimed as an indicator of infection, as it is increased proportionally as the severity of the infectious process increases. Therefore, sedimentation time should be inversely proportional to the uric acid reading. In other words: In a given infectious process, blood uric acid should be above normal, but sedimentation time should be more rapid.

The erythrocyte sedimentation rate has been found to be of particular value as an aid in the diagnosis of tuberculosis, and in determining the activity and progress of the disease and thus helping in planning proper treatment. While not always precisely accurate, the practical value of the test is such that it is now a routine procedure in most institutions and clinics specializing in the care of tubercular patients.

The applications of this test are continually widening, so that its proper performance should be a part of the regular technic of urological diagnosis.

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## CHAPTER IV

### INSTRUMENTAL EXAMINATION

#### A URETHRAL EXPLORATION (WITH BOUGIES, SOUNDS, AND FILIFORMS)

##### *Instruments*

Bulbed bougies, sounds, filiforms and followers, and catheters are the instruments customarily employed in manual exploration of the urethra.

**Bougies** Bougies are solid, flexible instruments made of gum impregnated woven fabric. The bulbed bougies come in various sizes and with olivary or acorn tips. It is well to have a fairly extensive range of sizes in each pattern.

**Sounds** Sounds are solid metal instruments, straight for females but of varying shapes for males, the different curves being merely for the purpose of more readily overcoming certain types of obstruction and distortion of the urethra. Sounds are manufactured in graduated sizes, ranging from the baby size, No 10 French, to No 36 French. They are obtainable in sets with a sufficient range of sizes (Nos 16 to 28 French) to permit routine employment, as for gradual dilatation of the urethra.

**Filiforms** A filiform is a fine, wire like instrument, properly a bougie, to which is usually attached a "follower," or dilator. The fine instrument is first passed, effecting entrance in even an apparently occluded urethra. The more rigid instrument follows in its wake. The lower end of the filiform is formed like a female thread, to fit over the male thread on the metal catheter or sound. Filiforms made of whalebone or rubberized silk are often more satisfactory than the metal ones.

It is most important that this instrument be perfectly fitted together before it is introduced into the urethra. Several sizes of threads are in use for attaching the filiforms to their followers. There are a French, an English, and a German standard, and great care must be taken to have the filiforms associated with their proper followers. The threads should never be forced together, nor should there be used a combination in which the threads fit very loosely but still hang together when tightened up. Should the two parts become separated while in use, it might be impossible to retrieve the filiform without recourse to operation.

The French thread being the smallest in diameter, is the most useful because it permits a smaller and more gracefully tapered follower

### *Preparation for Instrumentation*

The same general precautions against infection and trauma must be observed in manual exploration of the urethra as in any surgical procedure. Instrumentation is required most frequently in the presence of infection of the urinary or genital tract but every care should be taken not to carry additional infection from the outside or to convey infection from the lower to a higher part of the tract. Acute infection contra indicates instrumental exploration.

**Preparation of the Patient.** The external genitalia the urethral meatus and its immediate vicinity are cleansed with green soap and sterile water followed by sponging with an antiseptic (bichloride of mercury 1:1000 oxycyanide of mercury 1:1000). In the male the anterior urethra is irrigated with a mild antiseptic solution such as boric acid 2 per cent or oxycyanide of mercury 1:6000. Sterilization of the urethra can be satisfactorily secured by injecting merocyl 1:500. In the female irrigation of the urethra is unnecessary.

Some urologists paint the meatus with tincture of metaphen 1:200 tincture of mercresin (undiluted) or other antiseptic.

**Preparation of the Instruments.** The two essentials in the preparation of the instruments are sterilization and thorough lubrication (with K Y jelly sterile oil or sterile glycerine). Boiling is usually the best means of sterilization but formalin cabinets are also satisfactory. Bougies require careful handling. Immediately after being used they should be cleansed with soap and water and immersed in oxycyanide of mercury 1:1000 for 30 minutes. They are then boiled for 2 minutes dried and placed in the formalin cabinet. Any longer period of boiling causes such disintegration of the rubber that the instrument is quickly destroyed.

**Preparation of the Examiner.** Sterile gloves are not necessary to pass sounds catheters or bougies provided the greatest care is taken to see that the part of the instrument entering the patient is not contaminated by anything unsterile. Solid or rigid instruments are easily handled by the external end and sterile forceps may be used to grasp the more flexible instruments.

### *Anesthesia*

With thorough lubrication and skilful technic anesthesia is usually unnecessary for ordinary examination of the urethra with sounds bougies

or catheters For very nervous persons and those with some local abnormality that is likely to produce uncommon pain, anesthetization of the urethra is frequently necessary (Urethroscopy, Anesthesia, p 100)

*Technic of Urethral Exploration (with Sounds, Bougies, Filiforms)*

**Bulbed bougies** of graduated sizes, are used to localize strictures of the anterior urethra and estimate their caliber Sounds are used to localize strictures of the deep urethra and infiltrations and infectious foci of the anterior urethra

The technic of passing sounds, bougies and filiforms is essentially similar

**Bougies** The patient lies upon his back, with the thighs well separated The examiner stands between the patient's thighs or, if more convenient, at his left side

Holding the penis erect between the thumb and forefinger of his left hand, the examiner, with his right hand, introduces a well lubricated No 24 or No 26 French bulbed bougie into the urethra If the urethra is normal, the bulb of the instrument can ordinarily be passed as far as the external sphincter with little effort Under steady but gentle pressure, the sphincter will generally relax, permitting passage of the tip into the prostatic urethra and, commonly, into the bladder itself Abnormalities of the urethra will hinder the free passage of the bulb and will impart to the examiner's hand sensations varying from a slight roughness to complete arrest of the instrument Outside palpation of the penis on the bulb will help to determine the extent of the stricture when localized

The utmost gentleness must be employed in passing an instrument into the urethra If the resistance to the passage of the bulb is not immediately overcome, the bougie must be withdrawn and one of smaller caliber substituted, and so on until a bougie small enough to pass the obstruction is introduced Before the larger bougie is withdrawn, the distance from the meatus at which its tip is arrested should be carefully noted

**Sounds** Urethras in which bougies are arrested low down can often be penetrated by sounds, which are utilized when the bulbed bougie will not pass As the beak of the male sound is curved, the penis must be held so that it inclines slightly toward the left, the sound being held so that its shaft is parallel to the patient's left groin The sound should be of the same caliber as the bougie which failed to pass, or one size

smaller. It should be passed very gently and slowly upward as far as possible. When the tip reaches the penoscrotal junction the handle should be slightly rotated medially which will facilitate passage of the tip into the bulbous urethra. External pressure behind the scrotum will then help to guide the tip into the membranous urethra and through the external sphincter and pressure upon the suspensory ligament will further aid its progress through the prostatic urethra and into the bladder.

If the first sound is successfully passed it should be withdrawn and a larger one introduced. Whenever the tip is arrested in its passage the exact location of the obstruction should be noted before the instrument is withdrawn.

Comparison should be made with the findings of physical examination palpating upon the sound. In this way it is often possible to locate and gauge the extent of areas of inflammation, strictures and other abnormalities.

**Filiforms.** If neither a bougie nor a sound can be passed, filiforms must be utilized. The extreme delicacy of these instruments demands great care in their manipulation. Filiforms should never be used in an empty bladder as the flexible shaft may break off if there is no fluid in which it can curl up. If there is a diverticulum in the urethra the filiform may double up in the sac making further passage of the instrument impossible and threatening trauma to the urethral wall or the making of a false passage if force is used to advance it. The filiform is such a useful instrument however that the time and patience necessary to its mastering are well worth while.

## B URETHRAL CATHETERIZATION

The urethral catheter in addition to its ordinary practical use may be employed in such a way as to give valuable diagnostic information. Among its more important diagnostic uses are (1) urethral exploration (2) obtaining sterile specimens particularly in women (3) determining the amount of residual urine (4) determining the capacity of the bladder (5) measuring bladder pressure (6) cystography.

### *Types of Urethral Catheters*

The most commonly used urethral catheters in the male are those of soft rubber. Catheters of woven fabrics (silk, linen, cotton) are also frequently employed. Metal catheters are not often used by present day urologists.

In women, metal and glass catheters are in common use. When the latter are employed, extreme care must be exercised to prevent breakage. The various types of rubber and woven fabric catheters used in men are also obtainable in shorter lengths for use in women.

**Sizes of Urethral Catheters** The urethral catheters in ordinary use range in size from No. 10 to No. 24 French, but, to meet special conditions, there are catheters as small as No. 4 French and as large as No. 34 French.

**Types of Catheter Tips** Rubber, latex, and woven fabric catheters (both urethral and ureteral) have various types of tips. The *solid tip* (or *velvet tip*) catheter has a solid, rounded or conical tip, and usually a single, lateral eye which is close to the tip. The *hollow-tip* catheter has an eye near the tip, with the lumen extending beyond the eye to the end of the catheter. The hollow tip permits the use of a metal stylet for the purpose of stiffening the catheter in cases where insertion is difficult. Some hollow tip catheters have two, four, or six openings for better drainage. The *whistle tip* catheter has an oblique opening in the tip and one or more lateral eyes. The open end makes this a particularly useful catheter for postoperative renal, ureteral, and perineal drainage, for suction drainage through a suprapubic drainage tube, and for irrigating the bladder through a suprapubic sinus following removal of the drainage tube. The *hole in tip* catheter has a small opening directly at its tip and a lateral eye near the tip. *Olive tip* catheters have a spherical or oval extension at the tip.

**Rubber Catheters** The most commonly used urethral catheters are those of soft red rubber or latex. These are of several types. The ordinary straight, solid tip instrument, with the same diameter throughout its length and usually but one eye, is the most commonly used in general hospital work, but because it does not permit the use of a stylet, and because of the poor drainage afforded by the single eye, this type is less useful to the urologist than the hollow tip rubber catheter with two, four, or six lateral eyes. There are also straight whistle tip, hole in tip, and Robinson hollow tip instruments, and coude shaped soft rubber and semi rigid (anode rubber compound) catheters.

**Self-retaining Rubber Catheters** There are several styles of self retaining rubber catheters especially designed for use as urethral indwelling catheters, as well as for draining the bladder suprapubically and for nephrostomy drainage. The Pezzer and Malecot mushroom catheters have expanding heads which are temporarily flattened by the use of a

straight stylet, thereby permitting insertion of the catheter. When the stylet is withdrawn, the head again expands, holding the catheter securely in place.

The Foley self retaining urethral catheter, now widely used for indwelling catheterization in both males and females, has practically supplanted older types of urethral catheters for preoperative and post operative drainage. The inflatable bag near the tip of the catheter has a fluid capacity of from 5 to 30 cc. The bag is integral with the outer wall of the catheter. A No. 14 to 18 French catheter with a 5 cc. bag is generally used for female patients, a No. 24 French catheter with a 30 cc. bag for male patients. Inflating the bag with 5 cc. (or 30 cc.) of sterile water, after the catheter has been inserted, anchors the instrument securely in the bladder. The absence of adhesive tape or other maintaining devices adds much to the comfort of the patient.

**Metal Catheters** Metal catheters are constructed of silver, nickel, or chromium plate. Those for use in the male are always made slightly curved, the different curves being named in a manner corresponding to that of sounds. The dangers of catheterization in the male are increased when metal catheters are used, and extra caution must be exercised when passing them.

Many metal catheters are fitted at their tips with a male thread so that a woven filiform may be attached to the end to facilitate the passage of the catheter into the bladder.

**Woven-fabric Catheters** Woven fabric catheters are safer than the metal catheters and more rigid than the rubber ones. Great technical skill is required in the manufacture of these instruments, and even with the best of care their useful life is shorter than that of the rubber and metal catheters. The tube of woven fabric (linen, cotton, or silk) is impregnated with a special gum and carefully dried in an oven. Successive layers of gum, each followed by a drying period, are then applied until 50 or 60 coats have been added. This insures the proper flexibility and smoothness of surface.

Woven fabric catheters come in various shapes. There is the round tip catheter, resembling the ordinary rubber instrument, with the eye at one side or with several eyes. There are also olive tip catheters. These may have one or several curves, but the most common and useful form is the single curve instrument corresponding to the normal curve of the male urethra. When bent at an angle, a catheter is termed *coude*, if there is a double bend, it is called *bicoude*. Such catheters are service

able principally in cases of prostatic hypertrophy, when the urethra is greatly narrowed and distorted by the enlarged prostate. Of use also in such cases is the catheter with a long prostatic curve, sometimes called the *Guyon curve* after its designer.

**Obturator, or Stylets** The introduction of a catheter is facilitated if the catheter is stiffened by the insertion of a wire, called an obturator, or stylet. The velvet tip, whistle tip, and hole in tip catheters do not permit the use of a stylet, as its tip would protrude through the eye. In order to use a stylet, the eye must be at one side and not directly at the tip of the catheter, so that the tip of the stylet may pass beyond the eye, temporarily closing it. Some of these stylets are curved in various directions, in much the same way as sounds, in order to render easier the passage of the catheter through a partially occluded or abnormally shaped urethra.

A stiff obturator is run into the self retaining catheter to eliminate the expanding device while the catheter is being introduced. After it is in position, the obturator is withdrawn, and the retaining device expands so that the catheter cannot slip out.

Though the use of the stiffening device makes the introduction of the catheter easier, it is also more likely to traumatize an inflamed urethra, and great care must be observed in employing one.

### *Preparation for Catheterization*

**Preparation of the Patient and Examiner** This is the same as for urethral exploration with bougies and sounds (see p. 72).

**Preparation of the Instruments** All catheters, whether of rubber, woven material, metal, or glass, should be boiled after being used. Only those flexible woven instruments which are sufficiently well made to withstand boiling should be employed.

*Metal, glass* and *soft rubber* catheters should be rinsed in running cold water after being used, and allowed to remain in a basin of cresol, 2 per cent for 1 hour. They are then boiled for at least 10 minutes, allowed to drain overnight, and when dry, are placed in a formalin cabinet or sterilized by steam. *Metal* catheters should be carefully inspected for nicks or other signs of roughness. *Hard rubber* catheters are not immersed in cresol solution but are cleansed with soap and water before being boiled. *Woven fabric* catheters should be thoroughly cleansed with soap and water, care being taken that no particles of foreign substance cling to the instrument. They are then totally immersed in oxy

cyanide of mercury, 1 1,000 for 15 minutes, boiled for 1, or at the most, 2 minutes, and placed in a formalin cabinet or exposed to steam. The new latex catheters, made in the United States by the American Cystoscope Makers, Inc., can be sterilized 10 minutes at 240°F (10 pounds steam) or 15 minutes in boiling water, without injury.

Repeated laboratory tests have demonstrated to our entire satisfaction the efficacy of sterilization by formaldehyde vapor. The catheters should remain in the formalin cabinet at least 2 hours (better still overnight).

If steam sterilization is used, the catheters must be exposed to the steam for at least an hour.

In drying woven instruments, it must be impressed upon the one in charge of the sterilizing that each instrument must be kept separate from the others while soft—that is, until thoroughly dry.

### *Dangers of Infection*

Though regarded as one of the commonplaces of urological practice, catheterization is in reality a surgical procedure and should be conducted with all due precautions as regards asepsis and the avoidance of trauma.

Normally, the urine contained in the male bladder is sterile, though the anterior urethra has repeatedly been shown to be the habitat of various types of bacteria. In a normal male it is doubtful if organisms can ascend the deep urethra and penetrate the bladder without some mechanical aid. In the shorter female urethra such spontaneous infection is possible. The columnar epithelium is peculiarly adapted to resist bacterial invasion. It is only when one or more gonorrheal infections or, rarely, a non specific infection, has caused it to become smooth and pavement like, that this power of resistance is decreased, thus permitting a spontaneous infection of the bladder to take place along the male urethra.

In a high percentage of urinary tract infections, the infection is through the urethra (ascending infection). The importance of perfect asepsis would seem too obvious to require dwelling upon but experience demonstrates that despite constant reiteration of this warning there are still entirely too many instances of infection resulting from injudicious or careless catheterization.

### *Technic of Urethral Catheterization*

The most important factors in urethral catheterization may be summed up in the admonition. *Take plenty of time and be exceedingly gentle, haste and roughness are alike inexcusable.*



**Insertion of the Catheter.** The patient lies upon his back, with his head and shoulders slightly elevated, the knees flexed, and the thighs somewhat separated. The examiner stands at the left of the patient. With his left hand he grasps the penis, drawing it up toward the abdomen until it is perpendicular to the median line, and holds it so that the lips of the meatus are sufficiently separated to admit the tip of the catheter. Holding the catheter in his right hand, he introduces its tip into the urethra, and presses it gently forward until it has advanced as far as the bulbous urethra. When the eye of the catheter has passed through the internal sphincter and is actually in the bladder, its arrival will be signaled by sensing that the tip is free and also by the escape of urine at the end of the catheter. If doubt exists, a little fluid may be injected through the catheter with a syringe. If the fluid runs into the bladder, it will usually return through the depressed catheter. If the fluid does not return through the end of the depressed catheter, and does not remain in the bladder but runs out of the meatus alongside the catheter, it indicates that the curved portion of the urethra has not been passed and that the compressor urethrae muscle has not relaxed.

In catheterizing bladders, whether normal or diseased, it must be remembered that the bladder empties by the approximation of the anterior to the posterior wall and the rising of the floor and lowering of the dome in such a way as to form a Y shaped figure in section when the bladder is empty. Therefore, if the catheter is introduced too far into the bladder, its eye is likely to be obstructed by a collapse of the walls over its tip. By withdrawing the catheter slightly when this occurs, more fluid may be obtained from the incompletely emptied viscus. A good plan in evacuating the bladder is to withdraw the catheter slowly as the fluid flows out, the eye being thus kept clear of the contracting walls.

Diseased conditions often make the introduction of a catheter difficult, if not impossible. The eye of the instrument may be occluded by clots, shreds of tissue, mucus or even calculi, or a sudden involuntary contraction may occur, which will dislodge the catheter and force it back into the urethra outside the vesical sphincter. With a toneless bladder it may be necessary to exert slight pressure upon the hypogastrium. The extent of its contractile power can be fairly well gauged by observing the stream of urine as it flows from the end of the catheter, a steady, curved stream indicating that the bladder tone is still good.

Catheterization of the female will usually be found a much simpler

procedure, although greater difficulty may be experienced in maintaining asepsis because of the likelihood of pathogenic organisms infecting the meatus from the vulva

**Shape of the Catheter** The shape of the catheter used in urethral catheterization is important. If it is to enter the bladder properly the catheter after passing the bulbomembranous junction must correspond in shape to the curve at this point. The metal and some of the woven fabric instruments come already curved either following the normal curve of the urethra or shaped to conform to any possible deviation from the normal curve such as might be caused by prostatic hypertrophy. The straight flexible instruments can be made to assume the proper shape by pressure upon the urethra in its curved portion. As the pendulous part of the urethra is straight from the meatus to the bulbomembranous junction a straight instrument if flexible will penetrate as far as this point. But when the bulbomembranous junction has been passed a fixed canal is encountered and considerable dexterity is now required to avoid irritation to the urethral mucosa and injury to the posterior wall of the bladder as a result of pushing the tip too far back into the viscus.

Neurotic individuals are likely to exhibit sensitive points in the anterior urethra even if little or no organic disturbance exists. Anesthetization may sometimes be necessary but can usually be dispensed with after the first successful insertion of the instrument. Ordinarily pain can be minimized by the generous use of lubricant, passing the instrument slowly and by grasping the penis and extending the urethra at the same time making perineal pressure on the bulbomembranous junction. This will make less acute the angle formed by the junction of the pendulous and fixed portions of the urethra.

Even if no actual stricture exists a contraction of the sphincter urethrae muscle may offer resistance to a straight instrument that has penetrated easily to the bulbomembranous junction. Neurotic individuals or those on whom the catheter is passed for the first time are more apt to present this difficulty. By elongating and depressing the penis so as to stretch the urethra and by making slight perineal pressure even a straight instrument can usually be made to pass. Care must be taken not to exert too much pressure and to direct the tip properly.

The floor of the urethra at the bulbomembranous junction is the area most likely to be traumatized. Whether the instrument be straight or curved one must be careful to keep close to the roof of the urethra until it has entered the curved portion pushing forward with a slow gliding movement.

**Use of Erect Position** If difficulty is experienced in passing a catheter with the patient in the usual dorsal position, it may sometimes be overcome by having him assume the erect posture. This is particularly true in two classes of patients: those subject to spasm of the compressor urethrae muscle and those presenting a pocket, or diverticulum, at the bulbomembranous junction.

When a diverticulum is present at the bulbomembranous junction, depressing the handle of the instrument seems to engage it in the pocket instead of directing it into the fixed portion of the curved urethra. If, while the handle is depressed, the instrument is pulled outward for a quarter of an inch, very gently, so that the beak comes up a little more on the roof of the urethra, and the handle is again depressed, the beak will frequently enter the curved canal. Pressure by the fingers of the left hand on the perineum over the beak is also helpful. Similar difficulties are sometimes encountered in old men, in whom the urethra exhibits a tendency to sag at the bulb. Urethrography is now routinely employed by us in doubtful cases.

#### *Determination of Residual Urine*

When there is reason to suspect that the bladder is being incompletely emptied, measures should be taken to determine exactly the amount of the residual urine. This is accomplished by having the patient void his urine, and when he has passed all that he can, immediately passing a catheter to draw off any urine which has not been expelled by voluntary effort. If only a few drams are obtained, it will indicate that there is little if any retention, but if the amount withdrawn is in high proportion to the normal urine content of a person the size and age of the subject under examination, it shows that there is marked retention—the degree being in direct proportion to the quantity of urine which cannot be voluntarily expelled.

A fairly accurate estimate of the amount of residual urine can be made, after intravenous or oral administration of skiodan or neo-iopax, by x ray examination of the bladder after the patient has voided all that he can (Excretion Urography as a Measure of Residual Urine, p. 171).

#### *Measurement of Bladder Pressure (Cystometry)*

The simultaneous measurement of the intravesical pressure and the total fluid content of the bladder, accomplished by means of a cystometer, is the most exact method we possess of estimating the functional ability of the detrusor vesicae. Cystometrograms are of great importance in differential diagnosis, permitting us to distinguish between vesical irregu-

larities of mechanical origin, as demonstrated by the cystoscope, and those of neurogenic origin, as recorded by the cystometer.

The procedure, its uses, and the interpretation of cystometrograms are discussed more fully in the section on Physiology of the Bladder (Cystometry, p 978).

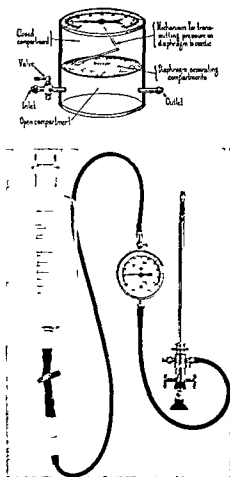


FIG 1 Lowsley-Hunt cystometer (Top) The cystometer in detail (Bottom) Showing the set up

Various cystometers have been devised, including those of Rose, Muschat and Johnson, Simons, Munro, Weyrauth, Lewis, and Mackenzie and Beck.

**Lowsley-Hunt Cystometer.** The Lowsley-Hunt cystometer (Fig 1) eliminates several of the objections attaching to the older instruments. It is smaller and more compact, and can be readily incorporated into

the routine set up for urological examination, needing only to be placed in the irrigating circuit. There is no air in the system between the registering device and the bladder, an important factor in the obtaining of accurate results, since this "air cushion," common to most cystometers, absorbs short, unmaintained increases of vesical pressure, which are not, therefore, recorded by the cystometer.

The cystometer is essentially a cast cylinder with a closed bottom and a glass face. It is divided into two compartments, one of which is water tight and holds the mechanism for recording the pressure in the second compartment on the dividing diaphragm. This pressure is registered by the needle on the dial, and is measured in millimeters of mercury. The second compartment is hollow and has an inlet and an outlet spigot, the inlet spigot having a valve for controlling the inflow. The mechanism is so protected that the entire instrument can be immersed in sterilizing solution.

The method of applying the cystometer is very simple. The patient is placed on an examining table, a woven silk catheter introduced, and the bladder emptied. The outlet of the cystometer is connected by a rubber tube to the catheter, and the cystometer is placed on the patient's abdomen over the pubis. The inlet is connected to the rubber tubing from an ordinary irrigating bottle. The fluid is then allowed to fill the bladder at the desired rate. After each 25 cc. of fluid injected, the inlet is closed and the vesical pressure recorded. The patient is requested to inform the operator of any sense of fulness, desire to void, pain or other abnormal sensations. When properly charted, these readings form a graph which accurately reveals the functional ability of the detrusor musculature.

If it is desired to combine cystometry with cystoscopy, it is necessary merely to place the cystometer in the irrigating circuit. If a slow, continuous filling of the bladder is desired, an ordinary Murphy drip may be placed in the circuit just below the irrigating bottle. The rate of inflow is controlled at the Murphy drip and the inflow valve of the cystometer is left open. The intravesical pressure is registered on the dial continuously and changes are recorded as they occur.

### C URETERAL CATHETERIZATION

The information yielded by the ureteral catheter is of primary importance in renal diagnosis. No examination of the upper urinary tract is complete without it. Ureteral catheterization is a development of cystoscopy and is discussed in its relation to that subject, on page 118. In

view of its importance in urological diagnosis however, a more detailed discussion of its uses and technic is appropriate here

In the early days of ureteral catheterization the procedure was looked upon as dangerous except in the hands of experts as well as more or less uncertain in its results, but improved instruments and greatly increased skill in their manipulation have largely done away with these objections and ureteral catheterization is today an essential and routine examination of the upper tract. It is now considered safe to catheterize the ureters if the bladder is sound and if strict asepsis is maintained though extreme care must always be exercised when the tip of the catheter reaches the renal pelvis for too great force may bruise the tissues sufficiently to cause more or less serious bleeding

### *Types of Ureteral Catheters*

**Sizes of Ureteral Catheters** Ordinary ureteral catheters vary in size from No 3 to No 16 French Nos 6 and 7 French being the sizes most frequently used

**Types of Ureteral Catheters** Ureteral catheters must be so constructed as to be capable of repeated sterilization. Those usually employed are long flexible hollow tubes made of woven silk covered with shellac and have a solid plainly rounded tip. One or sometimes two eyes near the tip and an opening at the other end of the instrument, permit the passage of urine from the renal pelvis or the ureter through the lumen of the catheter to the container placed at the open end. Ureteral catheters are also whistle tipped olive tipped or filiform tipped—that is much tapered and narrowed at the end

Ureteral catheters may be either *plain* or *x ray opaque*. The latter are made by impregnating the layers of fabric with bismuth salts or other substances designed to render them opaque to the roentgen rays. Such a catheter when passed up the ureter is plainly delineated on the x ray film revealing the exact course and position of the ureter

Ureteral catheters are usually divided into centimeter lengths by marks on their outer surface thus enabling the cystoscopist to tell at a glance just how far the catheter has advanced up the ureter toward the renal pelvis

*Wax bulbed catheters* are used for detecting stones in the ureter the rough surface of the stone making scratches on the wax as the catheter tip is forced past the concretion. This is a positive means of locating ureteral calculi

*Garceau catheters* are useful for dilating the lower end of the ureter to permit passage of a stone. They are also serviceable in pyelography

and renal function tests, as they prevent the escape of fluid between the catheter and the ureteral wall. For about two thirds of their length Garceau catheters are large. They then taper to a whistle tip. Directly behind the tip are two eyes, one on each side. The diameter of this catheter therefore varies considerably, being much less just behind the tip than at the point where the instrument begins to taper. The scale size, however, is indicated by the diameter of the lumen at its widest point—that is, where the tapering begins. Thus although it may be only No. 5 French at the tip, it will be designated as No. 11 or 13 French if that is its diameter at its widest point.

*Blasucci catheters* are filiform tipped to facilitate their passage through a stricture or past a stone.

**Stylets.** Ureteral catheterization sometimes fails because the catheters are not sufficiently rigid. It is therefore well to have at hand some properly sterilized wire stylets. The stylets usually supplied with the catheters by the manufacturer should be saved. Stylets cannot, of course, be used with whistle tip catheters.

#### *Uses of Ureteral Catheterization*

Ureteral catheterization by means of the indirect cystoscope permits the employment of synchronous bilateral ureteral catheterization, thus putting at our disposal the great diagnostic aid afforded by the simultaneous collection of urine from each kidney and the application of those bacteriological, chemical, microscopic and functional tests which are now regarded as indispensable to the fully established diagnosis.

Catheterization of the ureters is not, of course, necessary in all cases. On the other hand, the evidence gathered by a careful catheterization of both sides may be just the missing link in the chain of evidence without which the diagnosis cannot be established. Its greatest usefulness is in locating hematuric and pyogenic affections of the kidney. Stricture and ureteral calculi may also be detected by this means. Not the least of its uses is the determination of an absolute negative so far as the existence of kidney disease is concerned. The presumptive evidence will usually indicate whether or not investigation of the upper tract is necessary, but in cases of doubt it is better to perform the examination than to postpone or omit it.

The chief uses of ureteral catheterization may be summarized as follows:

- (1) It permits separate study of the urine from each kidney.
- (2) It makes possible the estimation of relative function, as well as the complete loss of function of either kidney.

(3) When hydronephrosis or pyonephrosis is present, ureteral catheterization not only enables one to establish this fact but also permits a fair estimate of the size of the renal pelvis. By injecting fluid until the pelvis is distended to its maximum and then withdrawing it and measuring the recovered fluid, accurate data regarding the capacity of the pelvis may be obtained.

(4) It serves to detect stricture or stone in the ureter.

(5) The ureteral catheter serves as a passageway for therapeutic irrigations and injections. The mere insertion of the catheter is often sufficient to stimulate an inactive kidney so that secretion is resumed in response to the pelvic lavage. Frequently the catheter serves to dilate a stricture or to make possible the passage of urine which has been obstructed by a calculus, neoplastic growth, etc.

(6) In pyelo-ureterography the ureteral catheter conveys the opaque medium.

(7) Left in position, after being filled with an opaque solution, it enables the examiner to differentiate external concretions and phleboliths from calculi located within the ureter.

### *Preparation for Ureteral Catheterization*

**Preparation of the Patient** This is described under Cystoscopy (p. 113).

**Preparation of Catheters** Ureteral catheters, because of their length and narrow lumen, are more difficult to clean than the shorter and larger urethral instruments. They should be thoroughly washed in warm, soapy water, and the water forced through them with a ureteral syringe, *immediately after being used* for if blood or other foreign material once becomes adherent to the inner surface its removal will be difficult if not impossible. When thoroughly cleansed, the catheter is placed in a tall glass jar filled with oxycyanide of mercury, 1:1000, and the solution siphoned through it by suction for at least 20 minutes, one end of the catheter being in the fluid and the remainder draining over the edge of the jar. When the catheter is draining freely, cold sterile water is forced through it, followed by the application of air. The catheters are then wrapped in a towel, allowed to drain overnight, and, when dry, are placed in the formalin cabinet, stylets being first run through them to make sure their lumina are clear.

Another method of cleaning and sterilizing ureteral catheters is to wash them well in soapy water, siphon oxycyanide of mercury, 1:1000 through them for 30 minutes, rinse in cold water, and boil them for 1



*minute* The American Cystoscope Makers' latex catheters, can be boiled for 15 minutes. Stylets, that have been sterilized by boiling for 10 minutes, are inserted into the catheters, which are then placed in glass cotton stoppered tubes that have been autoclaved for 30 minutes.

### *Technic of Ureteral Catheterization*

No matter what cystoscope is used, certain cardinal principles are observed in ureteral catheterization. The method followed by us is described under Cystoscopy (p. 118).

## D URETHROSCOPY

Visual inspection of the urethra occupies a prominent place in urological diagnosis, and is a very useful procedure, particularly when performed with one of our improved modern urethrosopes.

### *Instruments*

**Types of Instruments** There are various types of instruments for visual examination of the urethra. *Endoscopes* are straight tubes, open at both ends, some of them carrying the light at the inner end, while others have the light at the outer end. They are particularly useful for topical applications and treatments, in both men and women. *Urethrosopes* differ from endoscopes in being closed and in using water or air inflation. They give a far more extensive and detailed picture of the urethra than is obtainable through the endoscope, and are particularly adapted for examination and treatment of the posterior urethra. They are absolutely essential for complete urological diagnosis and treatment. *Cysto-urethrosopes*, as the term implies, are instruments for the examination and treatment of both the urethra and bladder.

The older instruments utilized reflected light for illumination, vision being direct and with the naked eye. Improvements in lens systems have revolutionized the structure of urethrosopes, and we now have a number of excellent instruments for visualization of the urethra.

**Kelly Endoscopic Tube** *Instruments of the endoscopic type, though not so popular as those equipped with lenses, for certain purposes offer advantages not afforded by the more complicated instruments. They are particularly valuable for treatment of the deep urethra, vesical neck, and trigone in the female.*

The best known endoscopic tube is that of Kelly, which consists of a set of various sized tubes applicable to the female urethra. The patient is placed in the genupectoral position, so that as soon as the instrument penetrates the urethra the bladder is distended by air. By means of a

reflector, external illumination is cast up the tube, enabling the ureteral orifices to be located and catheters inserted directly without touching the vesical wall

The chief disadvantages of the instrument are the high degree of proficiency on the part of the operator which it requires, the extremely fatiguing position which the patient must assume throughout the examination, and the fact that it is applicable only to females. Its advantages, however, more than overbalance its drawbacks. When local applications to the bladder must be made, the larger tube which can be employed greatly simplifies this procedure, cleansing of the ureteral orifice before insertion of the catheter, when necessary, can be readily accomplished, the catheter can be inserted directly into the orifice without touching a presumably infected bladder wall, the larger tubes afford better access for the removal of foreign bodies, dilatation of the ureters and other minor operations, and last, but by no means least in importance, is the ease with which the simply constructed tubes can be adequately sterilized.

**Elsner-Braasch Endoscope** An endoscopic tube applicable to male patients is that devised by Elsner and subsequently modified by Braasch, of the Mayo Clinic, so that it is now known as the Elsner Braasch instrument. The device consists of a sheath the beak of which carries a lamp. Two canals lie in the floor of this hollow tube which is inserted in the bladder with an obturator in place. When the instrument is in position, the obturator is withdrawn and the lower end of the tube shut off by a glass window, after which air or water is introduced to distend the bladder. After the bladder is illuminated, the ureteral openings are easily located, and the ureteral catheter can be passed through the canal provided for this purpose.

The usefulness of this instrument is limited its large caliber and long beak being objectionable in many types of work. Nevertheless, because of its large endoscopic tube, it gives to those treating male patients many of the advantages which the Kelly instrument provides for the gynecologists.

**McCarthy Observation and Operating Cysto-urethroscope** This instrument, first demonstrated to the profession in 1923, permits of direct ureteral catheterization without deflection and enables one to carry on intravesical and intraurethral operative manipulations with rigid appliances the while visualizing the distal end of these instruments with great precision.

The lamp is placed at the extreme end of the telescope. The objective

system consists of a double acting prism, having one surface at an angle of 20 degrees from the axis and another surface at 5 degrees. The sheath is straight, with the vesical end cut obliquely to permit better visualization. The sheaths are of varying caliber and type, one, a single oval tube, the others consisting of two tubes—a large or main tube, to the upper wall of which a tunneled sheath is soldered, the upper and smaller tube carrying the telescopic apparatus. There are two terminal openings—the shorter tube admitting operative appliances, the longer being the carrier for telescope and lamp. The eye piece is far enough from the cystoscope proper to give a working space of about 5 cm.

The manipulation of this instrument is extremely simple. The sheath permits the introduction of such straight, rigid instruments as forceps,

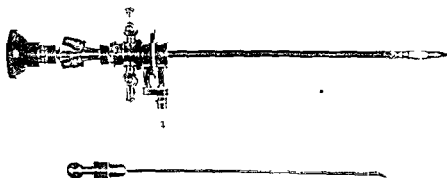


FIG. 2 Butterfield double catheterizing children's cysto-urethroscope

scissors and bougies. The telescope is adjustable to sheaths of varying calibers and lengths.

This instrument is intended by its designer to serve as a direct observation instrument for the bladder and as an operating instrument for the urethra, trigone, and ureters. It permits, in both male and female, the insertion of the wax tipped catheter. In the female, it permits the operative intraurethral and intravesical manipulations made possible by the Kelly type of female endoscope without placing the patient in the fatiguing position required by the latter instrument.

**Butterfield Double-catheterizing Children's Cysto-urethroscope**  
While quite conventional in its general outlines, this instrument (Fig 2), designed by Dr Paul M Butterfield, is distinguished from the more widely used adult instruments by many details which are necessary for its adaptation to the smaller anatomical structures.

The sheath is of the convex type,  $4\frac{1}{2}$  inches in working length and of

No 15-French caliber The lamp is housed somewhat back from the beak, parallel to the axis of the sheath and immediately adjacent to the aperture for the objective lens of the telescope Its location permits direct illumination of the field, making possible precise examination of the verumontanum, sphincters, and all parts of the urethra A second aperture, separated by a bridge from the first, provides an exit for the catheters, this bridge inclines downward from the catheter aperture and serves as a fixed deflector

The instrument accommodates two No 4-French catheters or electrodes, with space for irrigation, and has a removable telescope Constant irrigation can be maintained through the stop cocks on the sheath

With this instrument one may catheterize both ureters of a child of either sex It can also be used for fulguration and other small operative procedures

**Butterfield Female Urethroscope and Infant Vaginoscope** This instrument is convenient and effective for examination of the entire female urethra, as well as the anterior portion of the male canal When used in the vagina, a large rubber disc is employed to seal the vaginal vault for water distention

The instrument is in the form of a straight sheath oval in cross section with a working length of  $3\frac{1}{4}$  inches and a caliber of No 18 French (Figs 3 to 6) A McCarthy foroblique telescope,  $6\frac{1}{4}$  inches in over all length, is used with a fixed deflector for directing a flexible electrode or catheter A single electrode or catheter channel is provided, to accommodate a small cutting loop, fulgurating electrode or a No 6 catheter Stop cocks are provided for continuous irrigation The telescope is removable from the sheath Ease of manipulation is enhanced by the shortness of the instrument and by the fact that no obturator is necessary for its introduction

Its use is especially indicated in cases of gonorrheal endocervicitis in infants and children The short telescope affords a visual field of unusual size and brilliancy, and permits more precise study and treatment of pathological conditions, such as cysts, polyps and papillomatous masses In the adult male, the instrument may be used for fulguration of infected glands of the anterior urethra

**Lowsley Forward-looking Urethroscope** The Lowsley forward looking urethroscope was designed to fill a long felt need for a urethroscope with a forward looking lens system, which, with water or air distention, would permit good visualization of the entire circumference of

the urethra in one field, and would, at the same time, allow the carrying out of direct instrumentation and application of treatment to the urethra.

The instrument consists of a metal sheath 14 cm. long and No. 28-French in diameter, supplied with a water-cock for the purpose of introducing water for distention and with a screw-expanding obturator which extends beyond the end of the sheath and facilitates its passage into and through the urethra.

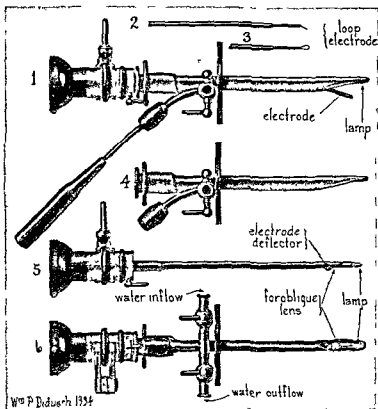


FIG 3 Butterfield female urethroscope and infant vaginoscope. (1) Instrument assembled, with electrode (seen from side) (2, 3) Loop electrode (4) Outer sheath (5) Urethroscope with foroblique lens and lamp (6) Instrument as seen from below, with water cocks

The telescope is of the McCarthy foroblique pattern, but differs in that the lamp is placed *beside* the objective lens of the telescope and extends only 5 mm beyond it, thus affording an exceptionally good illumination for the urethra. By changing the lamp's position, objects lying between the lamp and the objective lens are admirably illuminated. The room sacrificed by placing the lamp beside the telescope is compensated for by combining the lamp-carrier with an irrigating channel,

thereby reserving in the lumen of the tube the largest possible space for operative instruments

This urethroscope makes possible a thorough inspection of the mucosa of the entire urethra and detection of ulcerations congested spots, small abscesses, or other pathological changes. It affords an excellent view of the verumontanum, together with the orifices of the utricle and ejacu-

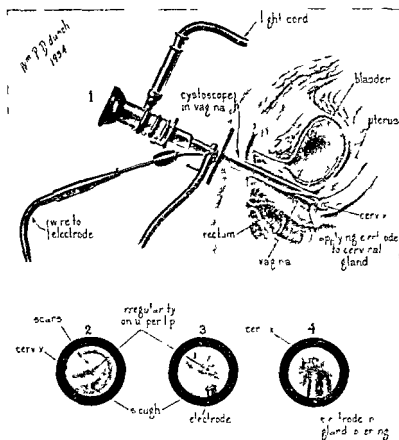


FIG 4 Butterfield female urethroscope and infant vaginoscope (1) The urethroscope has been inserted into the vagina of a child and the electrode is being applied to infected cervical glands (2 3 4) Urethroscopic views of the cervix

latory ducts. Catheterization of the ejaculatory ducts may be easily carried out and the ducts, ampullae of the vasa deferentia, and even the epididymes may be outlined by the injection of a shadow-casting medium. Ulcerations and other pathological conditions may be treated by fulguration, with water as a medium, or by the application of medicaments on a special flexible holder.

The instrument is especially useful in penetrating otherwise impervious strictures of the urethra. Under direct vision, with a water distended urethra, a bougie as large as No. 10-French may be inserted into the occluded channel and the tight stricture dilated, thereby eliminating the uncertain and time-consuming method of passing numerous small bougies.

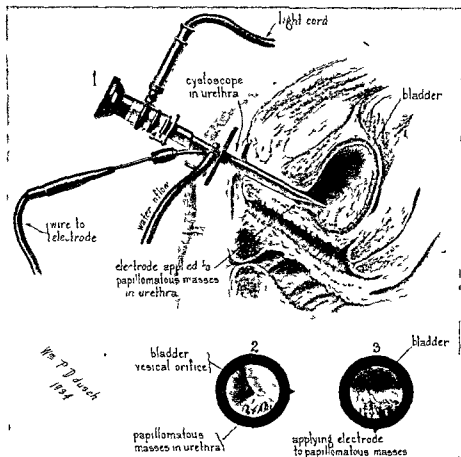


FIG. 5 Butterfield female urethroscope and infant vaginoscope. Removing papillomatous masses in the urethra.

into the urethra in the hope that one of them ultimately may enter the small aperture.

It is possible to obtain a perfect picture of congenital valves with this urethroscope because one looks forward and obliquely through the end of the tube and not through the side. This accurate observation makes it possible to determine whether such valves should be treated by simple fulguration, dilatation, or by removal with the resector. It also affords an excellent view of the vesical orifice by making visible the entire circum-

ference without rotating the instrument. Intrusions may be diagnosed quickly and accurately, and small projections on the posterior wall fulgurated or removed with the resector.

If lesions are present in any part of the lower urinary tract to which massive applications of a cauterizing or soothing solution are indicated,

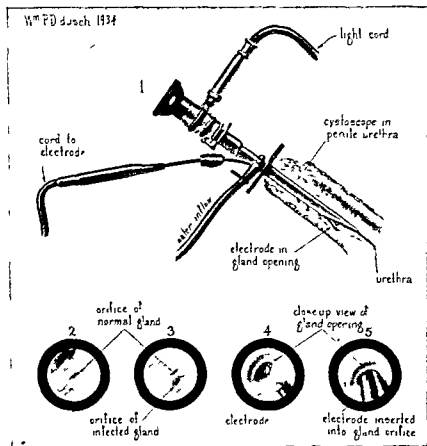


FIG. 6 Butterfield female urethroscope and infant vaginoscope. Fulgurating an infected gland in the anterior urethra of the male.

the inner unit of the instrument may be removed and the necessary treatment applied.

**Lowsley-Peterson Universal Urethroscope.** This instrument (Figs. 7 to 10), although designed for posterior urethral work, particularly catheterization of the ejaculatory ducts, gives good service in anterior urethroscopy (including coagulation of infected glands), fulguration of polyps in the posterior urethra and on the bladder floor, and unilateral



or bilateral ureteral catheterization and renal pelvic lavage. It incorporates a new idea, namely, having the entire assembly of telescope, light-carriers, and guides rotatable within the sheath.

The urethroscope is of 24-French caliber, round, and slightly longer than the usual urethroscope. The obturator is of the deflectible beak type, the position of the beak being controlled by the knurled knob on

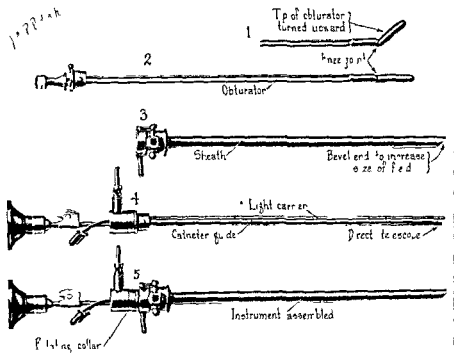


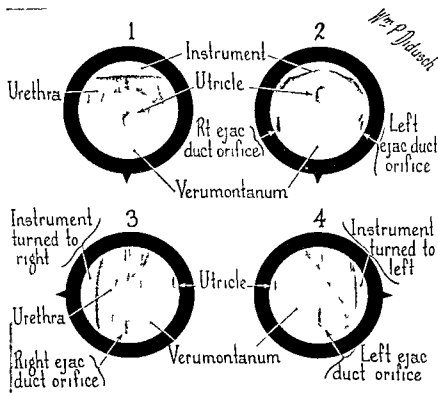
FIG 7 Lowsley-Peterson universal urethroscope. The obturator is placed in the sheath and its tip deflected by turning the knurled knob of the handle. The instrument is passed into the bladder and inverted as one would pass a concave cystoscope for examination of the trigone. The obturator is then straightened and withdrawn, and light and water connections made. The sheath should be permitted to fill with water before the telescopic unit is inserted. Before insertion, the telescope should be adjusted so that a small sector of the sheath remains visible at from 10 to 12 o'clock, with the cable connecting post at 6 o'clock.

the handle. The sheath is beveled at its distal end to increase the size of the field and provide a canopy for the verumontanum. The telescope is of the direct-vision type and adjustable in position. The light-carrier and catheter guides form one unit with the telescope, the entire assembly being rotatable in the sheath by means of a collar.

Two tubular guides of No. 5 French capacity run along the light-carrier. The external ends of the guides are long and sufficiently curved

to keep the catheters away from the examiner's face. The internal ends are shorter than the light carrier and are not provided with special deflectors, the direction of the catheters being given by the position and pointing of the instrument.

**Other Urethroscopic Instruments** Other present day instruments for visualization and treatment of the urethra are those of Hugh H. Young, Squier, Chetwood, Ballenger, and McCarthy's foroblique panendoscope.



**FIG 8** Lowsley Peterson universal urethroscope. Observation of the verumontanum. With the flow of water adjusted to a trickle, the instrument is slowly withdrawn from the bladder and observation of the vesical neck and posterior urethra made during withdrawal. As the verumontanum appears in the fenestra (1) the ocular end of the urethroscope is raised and slightly advanced until the visible section of the sheath is placed over and behind the verumontanum. The flow of water can now be shut off completely. By turning the telescopic unit to the right (3) or left (4) the lateral portions of the verumontanum may be examined.

### *Tables for Urological Examination and Treatment*

Specially designed examining and treatment tables are essential in urology. Numerous tables for urethroscopic, cystoscopic, and roentgenographic work have been designed from time to time, each succeeding

pattern offering some improvement over its predecessors. Notable among them are those of Young, Kretschmer, Foley, Sisk, Savier, Hyams, Squier, Bumpus, and Lowsley. At the Brady Foundation, in the New York Hospital, the Lowsley table is used.

**Lowsley Examining Table** This table is especially made for the examination of male patients. It is lower than the average table being only 28 inches high, so that the patient may seat himself upon it without

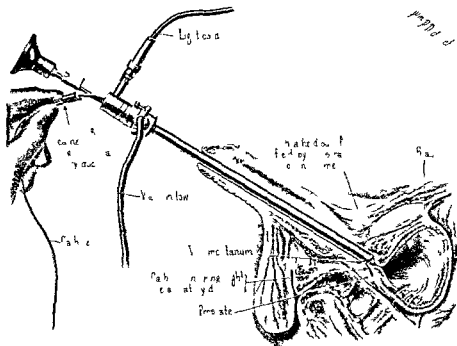


FIG 9 Lowsley Peterson universal urethroscope Catheterization of ejaculatory ducts located on the top of the verumontanum The ocular end of the urethroscope is raised until the bevel of the fenestra is flush with the floor of the posterior urethra and one appears to be looking down on the verumontanum Rotation of the telescopic unit will bring the posterior aspect of the verumontanum the two sides and its front into the field of vision as desired Retraction of the telescope permits observation of the entire verumontanum and insert on and passage of the catheter with unusual facility

using a stool. The legs at one end are fitted with casters but at the opposite end they are solid. Should it be necessary to move the table, it may therefore be lifted up and wheeled about as one trundles a wheel barrow. The top is of Monel metal, which does not rust and will not stain if solutions are spilled upon it.

**Lowsley Cystoscopic roentgenographic Table** In the designing of this table (Fig. 11) the aim has been to combine all the best features of

previously existing tables at the lowest possible cost. It combines all the functions of a urological examining, treatment, and x ray table and yet is free from complicated mechanism. With it the operator may easily and quickly secure every desired position, from the Trendelenburg to the practically vertical, by turning a single conveniently located wheel,

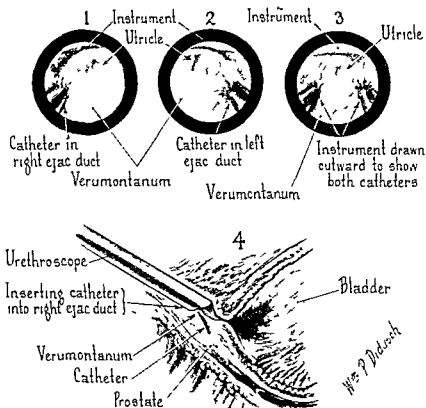


FIG 10 Lowsley Peterson universal urethroscope. Catheterization of ducts located on the frontal aspect of the verumontanum. The telescope is loosened and retracted until the light bulb and guides become visible. The catheter is then fed in until it nears the verumontanum. Rotation of the telescopic unit will give the proper direction to the catheter tip for entering the ejaculatory-duct orifices. Further passage should be made slowly and by short stages until 3 to 5 cm. have been passed.

with complete comfort to the patient and the minimum of effort on the part of the operator, regardless of the patient's weight.

The cystoscopic seat may be adjusted in relation to the angle of the top so as to hold the patient firmly and comfortably. This permits making cystoscopic examinations, introducing catheters, and making

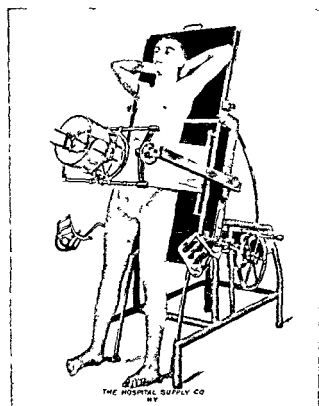
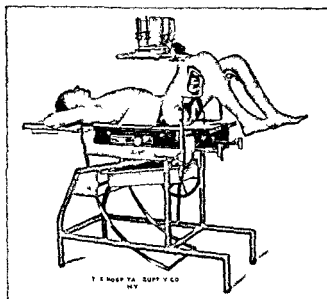


FIG 11 Lowsley cystoscopic radiographic table (Top) Patient in position for dorsal picture (Bottom) Patient in position for erect picture (Courtesy of the Hospital Supply Company)

radiographs without moving the patient The back rest may be inclined to any of four positions

The table is 36 inches high allowing the eye piece of the introduced cystoscope to be on a level with the average operator's eye when the patient is in the dorsal position

The table is outfitted with a Bucky diaphragm of the flat type permitting the use of 14 x 17 cassettes either lengthwise or crosswise The tube holder is so designed that the x ray tube moves in unison with the Bucky diaphragm and is always centered and in proper position for making radiographs regardless of the position of the table and without the necessity of further adjustment

### *Indications for Urethroscopic Examination*

Urethroscopy or endoscopy is indicated in cases of urinary frequency dysuria and terminal hematuria also in cases of sexual disturbances such as premature ejaculation absence of semen following ejaculation and kindred manifestations The urethroscope is helpful in determining the presence of urethral tumor and stone and in locating and gauging the extent of urethral strictures and ruptures of the urethra

### *Preparation for Urethroscopy*

**Preparation of the Patient** In the male the bladder is emptied by voiding and the patient prepared by cleansing of the external genitalia irrigation of the anterior urethra and sterilization of the urethra as described under Urethral Exploration with Bougies Sounds etc (p 72)

In the female the bladder is emptied by catheterization and the genitals cleansed as described under Urethral Exploration The meatus which is the most painful area must sometimes be dilated gradually before the endoscope can be introduced

**Preparation of the Examiner** See Urethral Exploration with Bougies etc (p 72)

**Preparation of Instruments** The preparation of urethroscopes and cystoscopes is described under Cystoscopy (p 111)

### *Anesthesia*

It is our custom to use local anesthesia in urethral manipulations whenever possible but in cases of excessive irritation or unstable temperament or in the aged sacral or spinal anesthesia may be advisable General anesthesia is usually necessary in young children or for extremely

neurotic patients Pentothal sodium, administered intravenously, is an excellent anesthetic for a rapid procedure

For local anesthesia, the instillation of novocaine borate, 2 per cent, or metycaine, 4 per cent, is satisfactory—18 to 20 cc usually being sufficient Instillation is accomplished with a bulbed syringe A few drops of cocaine hydrochloride, 10 per cent, in the posterior urethra is also very satisfactory, and may be used when there are no open lesions, but its employment is always accompanied by the danger of cocaine shock and poisoning from absorption Some urologists prefer the use of cocaine crystals applied to the posterior urethra in accordance with the method advocated by Bransford Lewis

Anesthetization for intraurethral procedures is discussed at length in the chapter on Anesthesia in Urology (Local Anesthesia for Intraurethral Procedures, p 213)

### *Technic of Urethroscopic Examination*

The tested and properly lubricated instrument is gently introduced through the urethra and into the bladder the obturator removed, and the residual urine collected and examined The telescope is then inserted and the water allowed to flow in This distends the viscus slowly, so that any abnormality of the mucous membrane may be noted The ureteral orifices are observed, and on withdrawing the instrument slowly the vesical orifice comes into view Abnormalities of this important structure are observed It is most important to note any enlargement of the subcervical group of tubules on its floor, as well as intravesical intrusion of the prostate gland, edema of the mucosa, granulations, and ulcerations Other pathological conditions to be watched for are diverticula, papillomas, congenital valves of the posterior urethra, and hypertrophy of the verumontanum, which, because of its size, sometimes causes retention of the urine

*Catheterization of the ejaculatory ducts* is frequently an important part of urethroscopic examination This may be accomplished by using special catheters (No 4 French ordinarily) through a urethroscope (Lowsley Peterson, McCarthy), and requires a clear picture of the anatomy of this region and considerable skill

### *Urethroscopic Appearance of the Male Urethra*

**Appearance of the Normal Male Urethra** The interior of the normal male urethra is marked by a smooth surface and a peach blossom color throughout

In the posterior urethra the floor is of particular interest. In that portion of the canal between the verumontanum and the vesical orifice there may sometimes be seen the small slits indicating the orifices of the 8 or 9 middle lobe tubules of the prostate gland. In health, however, these are often invisible. No structures, other than the smooth mucous membrane itself, are observable in the upper wall of the urethra. As the urethroscope is slowly withdrawn, the verumontanum comes into view. On its summit is the slit of the utricle, and on each side, slightly outward and about half way down, is seen the orifice of the ejaculatory duct. In the sulcus on each side appear the prostatic-duct orifices of the lateral lobes. The verumontanum tapers off as the instrument is further withdrawn, and the duct orifices of the posterior lobe come into view.

The membranous urethra is marked by distortion of the channel laterally. Cross-striations may be seen through the mucous lining.

The bulbous urethra is unmarked by any specific structure except occasional slits, which are the orifices of the ducts of Littre's glands. The remainder of the anterior urethra closes down over the end of the instrument in such a manner as to give it a cone shaped appearance, and in health nothing of note is observable except an occasional duct orifice from the glands of Littre. At the extreme end of the urethra the *lacuna magna* is noted.

**Appearance of Male Urethra in Disease** *Anomalies* An anomaly that has been frequently overlooked by the urologist is *congenital valves* of the posterior urethra. This may occur at the outermost portion of the verumontanum or at the upper end, the latter being rare, however. *Con genital diverticulum* of the urethra is another rare but possible anomaly, this is usually in the anterior urethra.

*Inflammation* The commonest lesion of the posterior urethra with which we have to deal is inflammation. This may appear as a slight blush of the mucosa or as an angry red, bleeding surface. Later, granulations may appear, and sometimes ulcerations with ragged bases are visible. In chronic inflammatory conditions the duct orifices throughout the urethra may appear as small, red slits.

*Prostatic Hypertrophy* Hypertrophy of the prostate is usually accompanied by intrusion of the gland into the bladder and urethra. Both of these conditions are visible through the urethroscope.

*Acquired Diverticulum* Diverticulum of the urethra is usually acquired. The acquired variety is generally located in the posterior urethra. The orifice is plainly visible through the urethroscope, and its size and pathological extent may be determined by a urethrogram.



*Urethral Calculus* Stone in the urethra is very easily diagnosed through the urethroscope, and small calculi may often be removed by a suitable grasping instrument used through the urethroscope

*Urethral Stricture* The most useful application of the modern urethroscope is in stricture of the urethra. Not only can the location and type of stricture be definitely determined, but a filiform, of the Philips whip type, may be threaded directly into the lumen and left there. After the removal of the instrument, dilators of varying sizes may be screwed on the filiform and the patient saved the harrowing experience of the old "fishing" procedures with many shapes and sizes of filiforms. Operation can thereby often be avoided.

*Tumor* Tumors of the urethra are encountered less frequently in men than in women but may occur in both sexes. The usual location is near the meatus, but they may develop anywhere in the canal. The growth may be either benign or malignant—more often the former. When terminal hematuria is present, it is most important to urethroscope the patient in order to rule out the possibility of urethral tumor.

*Prolapse of the Urethra* This condition is also less common in men than in women. The urethroscope is useful in determining the extent and degree of such abnormalities.

### *Appearance of the Female Urethra*

*Appearance of the Normal Female Urethra* The vesical orifice of the female rarely shows any deviation from the circular sphincteric closure behind the receding instrument. Occasionally it is slightly triangular in shape, and there may sometimes be folding of the mucosa on its floor.

On the floor of the urethra may be seen small evaginations. These are the orifices of the small ducts of the periurethral glands. Ordinarily the mucosa is pink, smooth, and glistening throughout the short length of the canal.

*Appearance of Female Urethra in Disease* *Inflammatory reaction* in the female urethra is frequently manifested in the form of edema, which may be bullous in type. In chronic cases granulations may be seen, usually on the urethral floor. *Tumor* and *prolapse of the urethra*, as stated above, are encountered more frequently in the female. A fairly common finding is a *caruncle*. This is usually located at the meatus, and should be completely excised or fulgurated, as it is a source of great annoyance and has a marked tendency to recurrence.

## E CYSTOSCOPY (WITH EXAMINATION OF THE UPPER TRACT)

*Instruments*

For the carrying out of cystoscopic examination and treatments the urologist should have at his disposal, in addition to the urethrosopes, endoscopes, and panendoscopes mentioned above an observation and catheterizing cystoscope, operating cystoscopes a small-calibered instrument for infants and children, and a cystoscopic x ray table

Among the many present-day instruments for examining and treating the bladder are those of Brown and Buerger, McCarthy Young, Bransford Lewis, Butterfield, Ravich, Lowsley, and Kirwin The Brown-Buerger, Young, and McCarthy cystoscopes all excellent instruments, are of essentially similar construction

The examiner will usually have some idea from the patient's history, as to what he wishes to ascertain from the examination If, for instance, the patient gives a history suggestive of tuberculosis the Brown Buerger examining and catheterizing cystoscope is indicated If renal colic is present, however, a telescope carrying a No 8 or No 9 French catheter should be used If a tumor of the bladder is suspected an observation cystoscope should be passed, and when the tumor has been located, an instrument, such as the Lowsley or Kirwin operating instrument, should be introduced for the purpose of securing a specimen for biopsy

**The Brown-Buerger Examining and Double-catheterizing Cystoscope**  
The instrument in most general use for visualizing the interior of the bladder is the Brown Buerger examining and double-catheterizing cystoscope The complete instrument consists of five parts the concave sheath, convex sheath, obturator, examining telescope and catheterizing telescope

The concave sheath is the sheath routinely used The convex sheath is more serviceable in contracted bladders and permits examination of the prostatic urethra and vesical neck as well as of the bladder

The large examining telescope fills almost the entire lumen of the sheath It gives an exceptionally large field of vision and a brilliant image, and permits rapid examination of the bladder and easy recognition of any pathological condition

The double-catheterizing telescope is smaller than the examining telescope, the balance of the lumen of the sheath being taken up by the two catheter tunnels Two No 7 French catheters can be freely passed in the No 24-French instrument and two No 6 French catheters in the No 21 French instrument.

**The Lewis Universal Operating Cystoscope** The cystoscope designed by Bransford Lewis consists of one sheath fenestrated on both convexity and concavity and supplied with two telescopes. This single sheath enables the operator to obtain any view desired, permits double catheterization by both direct and indirect methods, and affords room for the passage of all smaller standard instruments for urethral or intravesical operations, thus not requiring the provision of special instruments designed to fit the cystoscope alone.

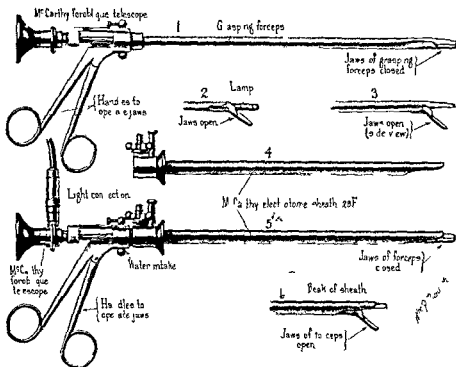


FIG. 12 Lowsley cystoscopic rongeur with McCarthy foroblique telescope. The various parts of the instrument are shown.

**Lowsley Cystoscopic Rongeur** The Lowsley cystoscopic rongeur (Figs. 12 and 13) is a combined grasping, crushing, and punching instrument. The forceps has a caliber of No. 24-French and takes either the standard McCarthy foroblique telescope No. 68 or the new and larger No. 68" foroblique telescope. The jaw opening is ample, and it is comparable to any grasping instrument in strength. Both jaws remain in the field of vision even when fully opened, and are serrated to provide a firm grasping surface. A stop cock is provided for irrigation. The size and shape of the instrument permit it to be passed through the

bakelite sheath of the McCarthy electrotome, etc., making it a valuable adjunct to resection equipment

This instrument is useful for removing stone fragments, pieces of catheter, or any foreign body from the bladder, and for grasping and removing calculi lodged in the ureteral orifice. If bits of excised tissue become dislodged during vesical neck resection and drop into the bladder,

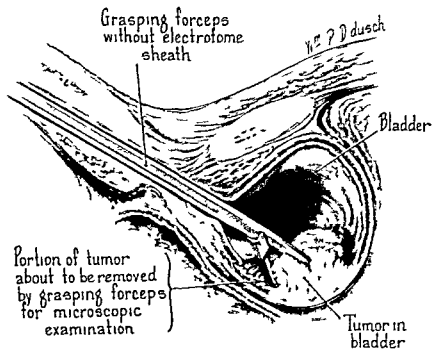


FIG. 13 Lowsley cystoscopic rongeur Taking a biopsy specimen of a tumor in the bladder

this rongeur may be passed through the sheath of the resectoscope and the pieces removed without removing the resectoscope

**Kirwin Lithotrite** The Kirwin lithotrite (Fig 14) affords excellent vision and illumination capable of reaching practically any part of the bladder. It is ideally adapted for work in the most difficult part of the bladder, namely, directly at the bladder neck. The jaws of the instrument have unusual grasping ability, due to the arrangement of teeth which fit into corresponding recesses as the jaws are closed. The jaws are also offset laterally to bring them directly into the center of the field

of vision The hardest concretions can be reduced to fragments without danger of injurious strain on the instrument

The large Young telescope is used Evacuation is easily carried out through the telescope channel, a stop cock being supplied to close off

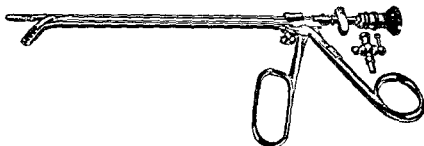


FIG 14 The Kirwin lithotrite (Courtesy of the American Cystoscope Makers Inc)

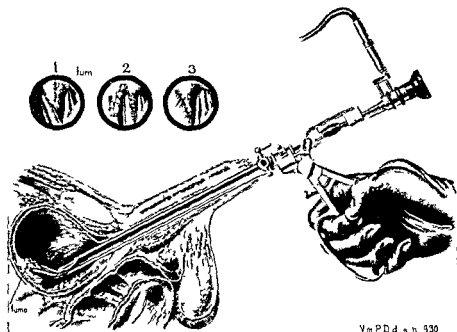


FIG 15 Kirwin cystoscopic rongeur Sectional view showing the removal of a piece of tumor tissue from the bladder wall

the telescope channel and simplify the process of evacuation and irrigation

Introduction of the lithotrite is accomplished with an obturator in place of the telescope

**Kirwin Rongeur** The Kirwin rongeur (Fig 15) has keen-edged,

smooth jaws for taking large biopsy specimens and for the removal of tumors. In all other respects the instrument is identical with the lithotrite described above, and, like it, is especially adapted for work at the vesical neck.

### *Indications and Contraindications*

**Indications for Cystoscopy** Cystoscopic examination is indicated whenever a lesion at or above the bladder neck is suspected, provided the patient's general condition permits the procedure. Where *urinary frequency* has existed over a long period of time cystoscopic examination is advisable to determine whether the frequency is due to a lesion of the urethra, bladder, or upper urinary tract. *Dysuria* or *nocturia* of long duration likewise indicates the need for intravesical investigation.

*Changes in the urinary stream* suggest some obstruction in the urethra or at the vesical neck requiring cystoscopic investigation. Enlargement of the prostate, felt through the rectum, will naturally lead the operator to conclude that a cystoscopic examination is desirable unless the condition is so marked that operation can be decided upon without such inspection.

*Painless hematuria* urgently demands cystoscopic investigation and bilateral pyelography, in order to determine the source and cause of the bleeding. Hematuria may be of several types: (1) diffuse hematuria in which the blood and urine are thoroughly mixed and there are no clots—a form indicating usually an upper urinary tract lesion, (2) terminal hematuria, namely, the passage of more or less blood with the last drops of urine following passage of clear urine—a form which usually points to some bladder lesion such as stone or more frequently, tumor, (3) clots in the urine indicating as a rule that the bleeding has its source in the bladder since blood coming from the kidneys is well mixed with small quantities of urine and large clots do not form.

*Pain* in the suprapubic region may indicate the presence of a lesion grave enough for cystoscopic investigation. Pain in the costovertebral angle practically always means that there is renal disturbance, which requires investigation by cystoscopic or other urological means. Urological investigation is also indicated in most cases of pain in the right or left upper or lower quadrants. The diagnostic ability of the surgeon is often severely taxed when the patient complains of persistent pain in these regions and particularly in the right side and one cannot help but

be impressed by the large numbers of serious kidney and ureteral diseases that are overlooked in the enthusiasm of medical advisers to remove the appendix or some other organ from the right side. In a study by Lowsley and Twinem at the New York Hospital, of 84 patients complaining of right sided abdominal pain—more than 50 per cent of whom were in *correctly supposed to have simple chronic appendicitis or appendicitis with some other intra abdominal inflammation*, and 39 of whom had undergone some major surgical operation without relief of the symptoms—32 were found to have lesions of the upper urinary tract requiring operation on the kidney and 1 required operation on the ureter. The lesson to be learned from this study is that when there is persistent right sided, or left sided, abdominal pain the patient is entitled to cystoscopy and pyelography in order to arrive at a correct diagnosis or eliminate the upper urinary tract.

*Palpation of a mass in the loin, in the upper or lower quadrants, or in the suprapubic region* warrants a cystoscopic examination with investigation of the upper tract to determine whether or not the tumor is intraurinary or extraurinary. Pyelograms will often eliminate the mass as a urinary structure—a fact just as important to the examining surgeon as the discovery of a tumor of the urinary tract.

Many shadows are disclosed by the x ray, some of which may be in the region of the ureter or kidney. In many instances it will require a good excretory or retrograde pyelogram to eliminate the urinary tract, or to prove that the shadow is in the urinary tract by securing a filling defect. Since the gall bladder also is subject to calculus formation, and is located in the vicinity of the right kidney, suspected urinary calculi on the right side not infrequently turn out to be biliary calculi.

Emergency cystoscopy is indicated when a patient has uncontrollable renal colic, in the hope of passing a catheter beyond the point of obstruction. This if accomplished, may not only dislodge the calculus but will release the dammed back urine, thereby relieving the excruciating pain.

**Contraindications to Cystoscopy** It is just as important to know when to avoid cystoscopy (or urethroscopy) as when to undertake examination. Our rule is to avoid instrumental examination whenever possible in those suffering from long standing debilitating disease and in the aged and infirm in whom cystoscopy should be considered as a major procedure. Seriously diseased bladders should be subjected to

ing, and inspection, each part of the instrument is laid separately in a tray and covered by a towel. Be sure that both the inside and outside of the sheath is thoroughly dry. The tray is then placed in the formalin cabinet and the whole thoroughly sterilized.

If the 2 hours required for formalin sterilization cannot be allowed, the instrument may be put in oxycyanide of mercury solution, 1 1,000 for 15 minutes. Everything that may be needed should be placed in the solution: obturators, telescopes, rubber tips, catheters, etc. After immersion in oxycyanide solution, instruments should be rinsed off with sterile water before they are again used as the solution might prove irritating to the mucosa. If the instruments are not to be used immediately, they should be dried thoroughly and stored in the formalin cabinet.

Cystan, a green solution of phenylmercuric acetate, has been found particularly effective for the disinfection of instruments which cannot be boiled. Immersion for 15 minutes is satisfactory.

*Testing Assembled Apparatus Before Using.* When all the units—cystoscope, lighting system and irrigator—have been properly arranged the assembled instrument must be tested before the examination is begun.<sup>1</sup>

*Preparation of Armamentarium.* Cystoscopy is usually carried out in an especially equipped room in a hospital or physician's office. By using a battery box, however, plain cystoscopy may be done anywhere, with the patient lying on his bed or on an ordinary table.

*For cystoscopy with examination of the upper tract* there will be required in addition to the cystoscopic x-ray table a sterile graduated irrigating jar, which is suspended above the table or attached to a nearby wall at a height of about two feet from the patient, a sterilizer containing distilled water, ureteral catheters of various sizes and tips for any unusual condition that might be encountered, x-ray-opaque ureteral catheters, and the cystoscopist's gown and gloves, towels, a cystoscopic sheet, and the patient's surgical stockings (all sterile).

There will also be needed materials for cleansing and sterilizing the field, anesthetizing solution and a bulb syringe for its instillation, a soft rubber urethral catheter, No. 14 or 16 French, 7 test tubes for the collection of urinary specimens, a urine specimen bottle for bladder urine, an alcohol lamp for flaming the culture tubes, and alcohol for sterilizing the catheter tips before inserting them in the sterile culture.

<sup>1</sup>Lowsley and Kirwin. *Urology for Nurses (Cystoscopic Instruments Testing Assembled Cystoscopic Apparatus Before Using)* pp. 82-92. Phila. J. B. Lippincott Co. 1936.



tubes, an ampoule of phenolsulphonphthalein and a hypodermic syringe, an ampoule of indigo carmine, skiodan, sodium iodide, or other opaque solution, and two ureteral syringes for its injection, an unperforated rubber tip to block the opening in the cystoscope if only one catheter is to be used. Distilled water for irrigating the catheters and rivanol dextrose, acriflavine, or other antiseptic solution for irrigating the kidney pelvis should also be provided.

The irrigating reservoir is filled with the proper irrigating solution, warmed to body temperature or a little above. For most purposes sterile water, saline, or a mild antiseptic solution such as boric acid, 2 per cent can be used, depending on the preference of the examiner, but if the procedure is one in which a cutting current is to be employed, only sterile distilled water must be used because saline or other solutions rob the cutting electrode of its current and prevent it from cutting as intended. A sterile irrigating tip must be provided for each patient.

After the cystoscope has been assembled, the operator makes sure that the rheostat is connected, the lamps of the cystoscope functioning, and every part in perfect working order before the examination is begun. When electric cutting or fulguration is to be done, a dry battery box should always be used for cystoscopes and urethroscopes, so as to prevent any possibility of shock to patient and operator.

*Preparation of the Patient* For plain cystoscopy, the preparation of the patient is the same as for any urethral instrumentation.

*For cystoscopy with examination of the upper tract*, the patient is prepared as follows.

A laxative is given at 4 o'clock of the afternoon preceding a complete cystoscopic examination—preferably castor oil, which eliminates gas more satisfactorily than other cathartics. Only a light breakfast is permitted. A few hours before the time set for cystoscopy a soapsuds enema is given. This assures a minimum of gas in the colon, a condition which does not interfere with cystoscopy but does cause confusing shadows on the pyelogram. If examination is to be done in the afternoon, lunch is omitted.

At least 2 glasses of water should be drunk by an adult before cystoscopy, to insure the excretion of a sufficient quantity of urine for obtaining the necessary specimens and estimating the kidney function.

### *Anesthesia*

Local anesthesia in some form is advisable for cystoscopic examination whenever possible. Sacral or spinal anesthesia may be used when there

is great irritation, or a decidedly unstable temperament, or for the aged General anesthesia, such as gas-oxygen or ether, is usually necessary for young children and for extremely nervous patients. Pentothal sodium, administered intravenously, is satisfactory for a rapid procedure.

Ordinarily, however, the patient is instructed to void, or is catheterized if there is residual urine, and 2 ounces of novocaine borate, 2 per cent, metycaïne, 4 per cent, or nupercaine, 1:250 is instilled into the bladder and urethra by means of a bulb syringe. If there is spasm of the vesical orifice, preventing passage of fluid into the bladder, a small catheter may be used for introducing the anesthetizing solution. Some urologists prefer cocaine hydrochloride, 10 per cent, a few drops in the posterior urethra giving the best anesthesia. The amount of cocaine is only 1 grain to 10 drops, but this amount is seldom used—5 drops being sufficient.

With extremely neurotic patients it is always best to administer gas to introduce the cystoscope and insert the catheters. The cystoscope is then removed, leaving the catheters in position, with the end of the left or right catheter cut diagonally for identification. The patient is then allowed to regain consciousness, and the examination proceeded with as usual.

We have concluded that proper anesthesia is quite essential in this procedure, to eliminate all fear and pain, and our end results warrant this conclusion.

These various types of anesthesia are described in the chapter on Anesthesia in Urology (p. 213).

### *Technic of Cystoscopy*

The cystoscopic table should be readily adjustable, so that the patient may be placed in any position desired, though that most commonly used is the lithotomy. Great care should be taken to insure the patient's comfort on the table, as this is an important factor in the success of the examination.

A soft rubber catheter is passed into the bladder and a specimen collected under sterile conditions and sent to the laboratory for bacteriological and chemical examination. Two ounces of novocaine borate, 2 per cent, or other preferred anesthetic solution, is instilled through the catheter into the bladder with a urethral syringe. A half ounce of the anesthetizing solution is left in the posterior urethra, the anterior urethra filled with the solution and a urethral clamp applied to retain it there and distend the urethra until commencement of the examination. The

patient is draped with a cystoscopic sheet, a sterile towel covering the exposed pubic area while he is awaiting examination

If the patient is a male, a sound should be passed, before introduction of the cystoscope, to ascertain whether a urethral stricture is present. The average adult urethra readily admits a sheath the size of a No. 22 French sound. Smaller instruments are made for children.

As soon as the examiner has tested the instrument and assured himself that the illumination is correct, the well lubricated beak of the cystoscope is introduced as gently as possible. Difficulty may be experienced in passing the cystoscope, due to stricture of the urethra, prostatic hypertrophy, or spasm of the vesical sphincter. The passage of a cystoscope to the female bladder is usually a simple procedure as the urethra is short and not prone to stricture.

When the sheath has been passed, the obturator is removed and the catheterizing or convertible telescope inserted. At least 150 cc. of fluid must be allowed to run into the bladder in order to distend it sufficiently to visualize its interior. If the bladder is contracted or the cavity encroached upon by a tumor or an enlarged prostatic lobe, or if there is some pathological condition productive of extensive inflammatory thickening of the bladder wall, it may be impossible for the bladder to receive enough fluid to permit examination.

#### INSPECTION OF THE BLADDER

By tilting the beak of the cystoscope at different angles, the entire interior of the bladder may now be examined. It is well to divide the bladder wall into an imaginary clock dial and carefully inspect it section by section, noting any abnormalities such as stone, tumor, ulceration, granulation, trabeculation or diverticulum. This gentle rotation of the cystoscope should cause little discomfort to the patient.

**Appearance of the Normal Bladder.** Normally, the bladder mucosa is smooth, glistening, and of a peach blossom color—that of the trigone being of a somewhat deeper tone than in the remainder of the bladder.

The ureteral orifices appear as two small, longitudinal slits located on a slight ridge about 2.5 cm. from the vesical orifice and, with it, forming a triangle—the trigone. Any deviation from the normal, in the size, location, and number of the orifices, should be noted. Edema, bullous edema or ulceration about an orifice indicates infection above. It is important also to observe the manner in which each orifice functions and the appearance of the ejected urine.

The vesical orifice is last observed. Normally, this is smooth and

rounded and its floor like the trigone is somewhat deeper in color than the remainder of the bladder mucosa (see Plate I)

**Appearance of the Bladder in Disease** *Cystitis* In *acute* cystitis the mucous membrane changes from the peach blossom color of the normal membrane through which the vessels are clearly discernible to a diffuse reddish blush and the vessels are not visible being blotted out by the engorgement of the capillaries. Sometimes the inflammation is confined to certain areas giving the mucosa a blotchy appearance. The mucous membrane bleeds readily and if the instrument touches it the field often becomes clouded. It is unwise to cystoscope a patient with acute cystitis if it can possibly be avoided.

In *chronic* cystitis it is rare to see the entire mucous membrane equally involved. The trigonum vesicae and its vicinity are much more liable to be affected than is the remainder of the bladder. One of the commonest forms assumed by chronic cystitis is *bullous edema* which is often met with in tuberculosis and sometimes in long standing infection due to the colon bacillus. Ulceration is a later manifestation of long standing infection and often follows bullous edema. The elusive ulcer of Hunner does not follow this rule.

*Tuberculosis* Tuberculosis assumes a characteristic appearance in the bladder. It usually follows renal tuberculosis and the ureteral orifice on the affected side first becomes reddened and edematous. Subsequently there may be bullous edema and finally ulceration marked by a ragged base. The region about the ureteral orifice becomes involved as does also the vesical orifice. If the vesical orifice is involved without the ureteral orifices one immediately suspects that the lesion originated in the seminal tract and extends from the posterior urethra back into the bladder.

*Leukoplakia* In this condition the mucous membrane assumes a characteristic dead white appearance no blood vessels being observable in the diseased region. The area is sharply outlined and reminds one of gangrene of the skin.

*Hypertrophy of the Mucosa* This condition is marked by folding and overgrowth of the tissues and is usually caused by long standing edema.

*Prostatic Hypertrophy* In prostatic hypertrophy with obstruction grave damage is done to the bladder wall. Due to ineffectual efforts to empty the bladder completely the muscle bundles become enlarged and trabeculations form with cellules between. The interureteral ridge becomes enlarged and the entire trigonum vesicae elevated so that a pouch is formed behind the base of the trigone called the *bas fond*. The

vesical orifice shows the encroachment of the intruding portions of the prostate gland. This should be carefully noted and recorded, for it is by this examination that the wise surgeon decides whether to do a suprapubic or perineal prostatectomy or a vesical neck resection.

*Syphilis* Syphilis of the bladder is a very rare condition. When seen in the early stages, there may be a few ecchymotic areas. Gummas have been known to form in the vesical wall, and necrosis following this condition would reveal an ulcerated area to the cystoscopist.

*Purpura* Purpura may manifest itself in the bladder as well as in the skin. The condition is rare, but, when observed, has the appearance of multiple, fairly discreet ecchymotic areas, which involve the fundus of the bladder but not, usually, the trigone.

*Varices* Varices in the vesical mucosa are a fairly common finding and are often associated with some disturbance of the prostate gland. They are easily recognized by the examiner as enlarged tortuous dark tubes. When ruptured, they bleed profusely, sometimes requiring suprapubic drainage to remove the resulting clots. As soon as the bladder is opened, the bleeding usually stops due to the relief of pressure. Sometimes, however, cauterization with the high frequency current is necessary.

*Diverticulum* A vesical diverticulum usually presents to the observer's view a small, dark, rounded orifice, and cystography is necessary in order to determine its size.

*Calculus* The visualization of a stone in the bladder through the cystoscope is a most dramatic experience to a beginner. The stones are often very bizarre in their appearance. In the olden days, before the existence of the cystoscope, the diagnosis of stone was made by hearing and feeling the click of the stone as it struck against a metal instrument, such as the Thompson stone searcher. Today, however, a single view through the cystoscope is usually sufficient for the rendering of a definite diagnosis. Cystoscopy also enables the observer to decide on the proper method of removing the stone. A small calculus can easily be removed by the operating rongeur. It is unwise to remove larger stones with the lithotrite, as the danger of traumatism by this means far outweighs the danger of removal by a modern suprapubic cystotomy.

*Foreign Bodies* Objects of many kinds find their way into the urinary bladder—hat pins, hair pins, pencils, pieces of chewing gum, etc. Most of these are inserted through the urethra by the patients themselves, usually in the course of masturbation. Occasionally, a needle or pin, swallowed by the patient, may work its way into the bladder and be

discovered by cystoscopic examination. Most of these objects may be removed by the cystoscopic rongeur, but occasionally, after long residence in the presence of urine, there will be a massive deposit of salts, necessitating removal by suprapubic cystotomy.

**Vesical Fistula** Vesical fistulas will usually be located at the top of the bladder. Ordinarily, the fistula will appear through the cystoscope as a smoothly lined dark cavity somewhat irregular in shape. Some times, however, the wall may be granular and on rare occasions a stone may be seen clinging to an unabsorbed stitch.

**Rupture of the Bladder** In rupture of the bladder it is often possible to visualize the rent through the cystoscope and determine its location and size.

**Bladder Tumors** Vesical tumors vary greatly in size, location and degree of infiltration.

(a) *Benign tumors* other than papillomas are rare. Papillomas may be single, but usually are multiple. They vary in size from that of a pin head to a mass filling the entire bladder. They are usually located in the region of the urethral or a ureteral orifice but may occur anywhere in the viscus.

Among the benign tumors should be mentioned bilharziasis, an infestation occasionally seen in this country and due to infection with *Schistosoma haematobium*.

(b) *Malignant tumors* of the bladder are common. Such tumors are usually papillary and are more liable to be single than multiple. They may be pedunculated or sessile. Flat infiltrating tumors are also found.

After a tumor has been carefully observed the observation cystoscope is removed and replaced by the cystoscopic rongeur and a biopsy specimen sufficiently large for proper diagnosis is obtained.

**Ureterocele** In cases of congenital or acquired stricture of the ureteral orifice a bulging sac which empties rhythmically is found. This is called a *ureterocele*. The condition may vary from the size of a pea to a mass several centimeters in diameter.

The cystoscopic appearance of the bladder in these various pathological conditions will be more fully described later in the section on diseases of the bladder. (See Plates II to VII inclusive.)

#### URETERAL CATHETERIZATION

**Obtaining Urinary Specimens from Each Kidney** After the bladder has been examined and the ureteral orifices located and inspected ure-

teral catheters are inserted and specimens of urine collected from each kidney for microscopic and bacteriological examination and for estimation of urea

Ureteral catheters must be passed gently and slowly, bearing in mind that there is a sphincteric action to the ureteral orifice, that the ureter, being a muscular tube, is subject to spasm, and that its delicate mucosa is easily traumatized. The utmost care and delicacy of manipulation are necessary to avoid harm to any of the sensitive tissues involved, and keen judgment is required to be able to note the instant the tip of the catheter comes in contact with the renal pelvis. The examiner's eye must constantly mark the progress of the catheter into the lumen of the ureter, which is made possible by the markings provided upon most ureteral catheters. Should the fluid used to distend the bladder become clouded after catheterization of the first ureter, the field can be cleared by the irrigating attachment to the cystoscope, which permits the evacuation of the bladder and its refilling with fresh fluid. In any manipulation of this sort it is well to keep in mind the counsel given to his pupils by the great French urologist, Guyon: "Always regard all urological instruments such as the bougie, the sound, and the catheter, as but extensions of the fingers, were these so formed as to be able to penetrate as far as the instruments."

Ordinarily catheterization of the ureters is easily accomplished with our modern cystoscopes. If, however, the ureteral orifice is contracted, stenosed, or obscured by bullous edema, or if there is present a stricture, small calculus, or spasm of the ureter, the examiner's ingenuity may be taxed to the uttermost to accomplish this usually simple procedure. In the presence of inflammation, the catheter may penetrate the intramural portion of the ureter and fail to pass further. In such an event the injection of a little sterile olive oil or water may open up the channel sufficiently for passage of the instrument.

If x ray examination is to be made, an x ray opaque No. 7 or 6 French ureteral catheter is passed to each kidney pelvis, if the cystoscope will admit these. (It is necessary to use the operating channel for catheters larger than No. 7.) Whistle tip catheters should routinely be used because they facilitate the rapid collection of specimens. If difficulty is encountered in passing these, catheters with a different tip—olivary or filiform—but still No. 6 or 7 French in size, should be passed. Only if these likewise fail of passage should smaller sizes be tried.

The normal urinary flow through the catheter is peristaltic. A

steady, rapid flow may denote hydronephrosis, a nervous polyuria, or other abnormality. No flow from the catheter may be due to plugging of its lumen by mucus or a blood clot, to temporary anuria due to the presence of the catheter in the ureter and renal pelvis, or to a non-functioning kidney. Sometimes the flow may be started by irrigating the catheter with sterile water, or by "priming"—that is, compressing the ureteral syringe and releasing the pressure, the resultant suction causing the flow to start.

If, due to the presence of a very tight stricture or other pathological condition, it is impossible to pass any catheter into the kidney pelvis, a Garceau catheter should be at hand to plug the ureteral orifice tightly and thereby collect all urine passing down the ureter.

After the catheters are in the kidney pelvis, specimens are collected from each kidney. In our practice, a test tube labeled *culture of urine from right kidney* is attached to the catheter which has been passed to the right kidney and one marked for the left side is attached to the left catheter. The edges of the tubes are flamed and the catheter tips wiped off with an alcohol sponge before specimens are collected for bacteriological examination. When these tubes are sufficiently filled (1 cc.), they are removed. Tubes marked, respectively *right urea and microscopic* and *left urea and microscopic* are then attached to the right and left catheters and 2 cc. of urine collected in each tube. When the urine is to be tested for tubercle bacilli, or it is desired to determine its pH, at least 5 cc. should be collected in the urea and microscopic tubes.

**Examination of Ureteral Specimens** The urine obtained by ureteral catheterization should be examined as quickly as possible after collection.

*Microscopic examination* is first done, search being made for red blood cells, epithelial cells, casts, pus, bacteria and parasites. If pus is present, it should be noted whether the pus cells occur in clumps. Pus without organisms suggests tuberculosis. When blood is observed, it should be noted whether it occurs in large clots, small clots, or is diffused. Bleeding may occur from the trauma of insertion of the catheter. Microscopic examination of the urine is described in greater detail on page 35.

A *stained specimen* is next examined by the ordinary methods (p. 38), to determine whether there are present bacilli, cocci, or other evidence of bacterial invasion. Streptococci occur in chains, staphylococci in clusters. A motile rod is likely to be a colon bacillus unless found in an alkaline urine, when it is probably *Proteus vulgaris*. The most important stain to be made in a suspected case is that for tubercle bacilli.



A separate specimen is subjected to culture, to determine whether any of the ordinary bacteria are present (p 41) Many significant findings are to be obtained from a bacteriological study of the separate specimens from the two kidneys, and such an examination should be made in all cases of pyuria No growth on culture, and a negative smear in the presence of pus, is suggestive of an acid fast bacillus, such as the tubercle or smegma bacillus or some other organism that does not grow on ordinary media

Specimens are next examined for an *estimation of urea* (p 51), and the results checked against those of the phenolsulphonphthalein (or indigo carmine) test which is subsequently done If the urea varies greatly from the phthalein excretion, the examination should be repeated

#### TESTING RENAL FUNCTION

If the *phthalein test* (p 46) is to be made, a third set of tubes, marked *PSP right* and *PSP left*, is placed for the collection of these specimens We have used the following procedure for many years in the cystoscopic examination of patients One cc (0.006 Gm) of phenolsulphonphthalein is injected intravenously This should appear within 2 to 6 minutes in the normal kidney The two specimens are allowed to drop into test-tubes containing a little sodium hydroxide, 10 per cent, and, at the first appearance of the red coloring, the time is noted Specimens from both sides are collected for 10 minutes after the initial appearance of the red color If the kidneys are normal, each side should secrete 1 per cent per minute, so that at the end of 10 minutes after the initial appearance of the color each kidney should have secreted approximately 10 per cent of the dye If abnormal, there will be not only delay in the appearance time but a diminution in the amount secreted The functional capacity of each kidney may, therefore, be determined by this test, which is a quantitative one and may be estimated in percentages

The second important dye test on the separate specimens is the *indigo carmine test* (p 48) Unfortunately, this is not a quantitative test and therefore is not considered as valuable as the phenolsulphonphthalein test About 4 cc of a 4 per cent solution of indigo carmine may be given, if desired, to time the kidney function or to locate ureteral orifices In our practice, only the appearance time of the coloring is noted, and the quality of secretion is gauged by the color of the urine—whether it is a light or a dark blue Since the percentage of dye is not estimated, as in the phenolsulphonphthalein test, it is not necessary to collect specimens for examination

Both of these tests must be very carefully made, and if there is any evidence of blockage to the outflow of urine in the catheter, this must be noted and the test repeated, because such mechanical obstruction will give incorrect and misleading results

#### OBTAINING PYELO-URETEROGRAMS

Retrograde pyelo-ureterography is described under Roentgenography of the Genito-urinary Tract (Retrograde Pyelo-ureterography, p 129)

#### *After-Care of the Patient*

As cystoscopic and pyelographic examination is somewhat exhausting, most patients will need to rest for several hours at least after withdrawal of the cystoscope. Frequently, rest in bed overnight is desirable. If spinal anesthesia has been given, the patient's head must be kept lowered for 6 hours.

The injection of the pyelographic solution may cause some distress, if so, the patient should be put in a hot bath or a sitz bath for 20 minutes, the pulse being watched closely. Pain in the kidney or bladder region is usually relieved by rest in bed, sedatives, opium suppositories by rectum, and the application of heat to the kidney and suprapubic regions. Fluids are forced, to encourage kidney function. A close watch should be kept for blood in the urine and for signs of a chill, due to instrumentation or to a nervous reaction.

### F. CYSTOSCOPY AND URETHROSCOPY IN CHILDREN

#### *Instruments*

There are several excellent baby cystoscopes including those of Beer, Campbell, McCarthy, and Butterfield. One of the best for general purposes, and the one in use in the Brady Foundation of the New York Hospital, is the Butterfield double-catheterizing children's cysto-urethroscope (Fig 2), by means of which one may catheterize both ureters of a baby of either sex. With this instrument Lowsley has performed bilateral ureteral catheterization in a boy 9 months of age. Deming has catheterized an infant 1 day old.

The Butterfield female urethroscope and infant vaginoscope (Fig 3) is also a very useful instrument for use in the urethra and vagina of very young patients.

#### *Anesthesia*

Anesthesia may be produced by any of the accepted methods. For infants we prefer the use of gas-oxygen or ether by the drop method.

*Technic of Examination*

If the patient is a male, before attempting to pass the instrument through the urethra it is well to introduce a sound gently and note any obstruction encountered in the posterior urethra. Such obstruction would immediately make one suspicious of a congenital valve, in which event inspection of the urethra would be the chief object of the examination. The Butterfield urethroscope is excellent for this purpose.

If cystoscopy is necessary, the cystoscope, having been carefully tested as to proper lighting and well lubricated, is passed and the examination of the bladder conducted in the usual systematic manner, observing the fundus in its entirety first. The mucous membrane is examined, evidence of obstruction, in the form of trabeculations, cellules, or diverticula noted, and the bladder searched for stone, tumor, or other evidence of disease. The ureteral orifices are then examined, their size, location, and general appearance being noted. Lastly, the vesical orifice is carefully inspected.

The ureters are then catheterized with No. 4 or No. 5 French lead catheters; specimens obtained and examined microscopically, bacteriologically, and chemically, and the usual functional test (phenol sulphonphthalein) made.

Ureteropyelograms are obtained by injecting a non irritating opaque substance into the renal pelvis and ureter of each side, the catheter being withdrawn to the lower ureter while the opaque medium is being injected. Roentgenograms are taken with the patient in the prone and semi-erect postures in order to bring out any postural defects in the upper urinary tract.

It is most important to make a complete bilateral investigation when a child is being cystoscoped, since the fact that a general anesthetic is usually necessary makes repetition of the examination inadvisable.

Having made a complete cystoscopic and pyelographic examination and correlated the findings it is the rare case, indeed, which is not correctly diagnosed, if the disturbance is in either the upper or lower portion of the urinary tract.

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## CHAPTER V

### ROENTGENOGRAPHY OF THE GENITO URINARY TRACT

The first medical use to which the roentgen ray was put was a urological one—the demonstration of urinary calculus. In no field of medicine has roentgenography been of more signal value than in the diagnosis of diseases and anomalies of the genito urinary tract. Nearly three decades ago this value was vastly enhanced by the introduction of retrograde pyelography. Since then, improvements in the technic of retrograde pyelo ureterography, the introduction of excretory urography, and the production of less expensive, less irritative and toxic, and more satisfactory media have brought the roentgenographic diagnosis of urological lesions to a very high plane.

#### A PLAIN ROENTGENOGRAMS

Simple roentgenography, without the introduction of an opaque medium, is of great value despite its limitations, and is an absolute necessity in any complete urological investigation. Its chief importance is in the study of urinary calculus, but it is also useful in demonstrating the outline of the kidney and, consequently, deviations from the normal in its size, shape, position, and mobility. Frequently, there may be detected lesions of the surrounding viscera and of the spine which may be responsible for the symptoms attributed to the urinary organs. Since any abnormal finding in the areas of the kidneys, ureters, or bladder must be confirmed by the use of pyelography, ureterography, cystoscopy, wax tipped catheters, or x ray opaque ureteral catheters its value is largely supplementary, nevertheless, the plain x ray film affords the examiner a perspective which roentgenograms of special parts of the tract will not give him. This general exposure of the abdomen and pelvis should, therefore, always be the initial step in roentgenographic investigation of the urogenital tract, even though preliminary examination has indicated that only one side, or a particular area, is involved.

#### *Preparation of the Patient*

It is of the utmost importance, for successful roentgenographic examination, that not only the bladder but the intestinal tract be emptied,

as impacted feces and pockets of intestinal gas may cast shadows that will render the picture wholly unreliable. Castor oil is a dependable cathartic and should be administered 12 to 24 hours in advance of the examination. After the bowel has been thoroughly depleted, only a small quantity of food, calculated to produce but little residue, should be allowed. Some examiners restrict their patients to orange juice or milk the evening before, and permit nothing but water, or a cup of coffee or tea, on the morning of the examination, which preferably is carried out as early in the day as possible.

### *Routine Method of Securing Plain Roentgenograms*

When the Potter Bucky diaphragm with a soft tube is used, it is customary to make 4 exposures. The spark gap is 4 inches or less and the target film distance from 30 to 36 inches. A very obese patient may require a slightly harder tube, but when dealing with these subjects, it is better to make the exposure a trifle longer than to increase the penetration of the ray.

The renal region is generally filmed first. Two plates are made, one during inhalation and the other as the breath is being exhaled. This gives a picture bounded by the tenth rib above and the iliac crests below. Upon these two films the trained observer should be able to discern the outline of both kidneys, the transverse processes of the lumbar vertebrae, the outlines of the ilio psoas muscles, and the twelfth and eleventh ribs. It is a common observation that the kidney outlines will be more distinct upon the film taken during inspiration than upon that taken during exhalation. If stereoscopic films are used (and it is advisable to use them when possible), the entire pelvic cavity should be readily made out, and frequently the vesical cavity also will be plainly outlined.

### *Simple Roentgenograms of the Kidneys*

Plain roentgenograms of the kidneys are useful chiefly (1) in outlining the kidneys, and (2) in the study of renal calculus. Outlining the kidneys enables the examiner to note any abnormalities in their size, position, shape, or mobility, which is of diagnostic value mainly as indicating the necessity of complete urological investigation.

**The Kidney Outline.** Normally the right kidney lies at a slightly lower level than the left. The average length of the normal adult organ is 10 to 11 cm and the average width 5 to 7.5 cm, although the left kidney will usually be found to be longer and narrower than the

right If the patient takes a deep breath, the upper pole of the kidney will be at, and just beneath the eleventh rib, and the lower pole at the level of the third lumbar vertebra When the lungs have been emptied by forced expiration, both kidneys will lie about an inch above these levels If the roentgenogram shows marked deviation from these positions, or noticeable distortion of the kidney outlines, these observations should be carefully investigated and confirmed by pyelography

**Renal Calculus** Calcium, which is the main constituent of most kidney stones is decidedly opaque to the roentgen ray It has been estimated that fully four fifths of all urinary stones are predominantly composed of calcium, therefore, diagnoses established by roentgenograms should be correct in 80 per cent of cases Well marked shadows are cast by stones composed of calcium phosphate, calcium carbonate, or calcium oxylate When dealing with cystine calculi, or with a combination of ammonium, magnesium, and phosphate, the problem is more difficult Most technicians use a small cone and make supplementary films of each kidney separately If pure uratic or xanthic calculi are present, the film will give no hint of their existence Fortunately, these types of concretions are both relatively uncommon

The most frequent location of renal calculi is the renal pelvis A single stone usually assumes a rounded or roughly triangular shape, but there is endless variation to the forms these concretions may take The occasionally seen "mulberry" stone is an interesting example When there are several or multiple stones in a single pelvis, the shapes of the individual stones may vary greatly Sometimes a large stone forms in the pelvis and projects into one or more of the calyces, making a branching "staghorn" calculus

Shadows in the regions of the kidneys, ureters, or bladder are called *true* when caused by urinary calculi, and *false* when due to other factors Such shadows in the kidney area must therefore be checked by ureteral catheterization and pyelography It is well to take lateral views in all suspicious cases for such views will show any kidney stone in close relation to the spinal vertebrae, therefore failure to occupy this position in a lateral view is strong presumptive evidence *against* the shadow being cast by a renal stone

Many false shadows making for error, such as those cast by enteroliths, fruit stones, and other foreign material in the intestines, may be eliminated by proper preparation of the patient Other shadows that may inject an element of confusion are those due to faults of technic and those

cast by gall bladder stones abnormal exostoses upon the spinal column or ribs phleboliths and calcified tuberculous glands The skin overlying the kidney region should always be carefully examined for moles since these may cast confusing shadows on the film and lead to an erroneous diagnosis of stone in the kidney In a case reported by Delzell the patient was twice operated upon for renal calculus before the suspicious shadow was discovered to be caused by a deeply pigmented mole on the external skin

### *Roentgenograms of the Ureters*

**Ureteral Calculus** Ureteral stones should be visible on a properly taken film of the lower abdominal and pelvic regions but such a finding generally requires verification by the use of x ray opaque ureteral catheters or pyelo-ureterography

As a rule ureteral stones are small ovoid and cast a compact and sharply outlined shadow However stones which have descended as far as the lower third of the duct or present at the ureteral orifice are usually larger and cast a more rounded shadow Occasionally a small pointed stone may lodge at the ureteral orifice and remain there for some time without increasing in size probably because its shape permits fairly easy passage of the urine and consequently there is little or no deposit of salts upon the nucleus

Various extraureteral substances may produce shadows simulating stones within the duct calcified glands phleboliths enteroliths partially calcified uterine fibroids foreign bodies in the bowel and exostoses upon the pelvic bones or the transverse processes of the vertebrae All shadows in the region of the abdominal portion of the ureter require particularly careful identification because of the variability in position of this section of the duct

One of the best methods of determining whether a shadow is in the ureter in front of it or behind it is to take an oblique film of the involved side If the stone is in the ureter its relationship to the catheter will be identical in both the dorsal and oblique films Another good method is the double-exposure method suggested by Kretschmer This is based on an old law of physics namely that bodies on the same level will move at the same rate of speed If the stone is in the ureter in contact with the lead catheter it will retain the same relationship to it when the tube of the x ray machine is moved in making the second exposure as it showed in the first exposure made on the same plate



*Roentgenograms of the Bladder, Prostate, and Urethra*

**Bladder Calculus** Plain roentgenograms are of value in the study of stone and foreign bodies in the bladder, but do not compare with cystoscopy in this respect. Most bladder stones descend from the ureter and kidney, and frequently attain a considerable size by the time they are discovered. Not uncommonly, however, stones form in a vesical diverticulum. Such a diverticulum resembles a gall bladder similarly encumbered. Shadows in the bladder region that may require differentiation are those caused by uterine calcification, phleboliths, prostatic calculi, and intestinal contents. Contrast cystography or cystoscopy will be necessary to identify obscure shadows.

**Prostatic Calculi** Prostatic calculi usually appear in the roentgenogram as multiple, tiny seed like opacities, ranged behind the symphysis. There are also single, larger stones, usually of an oblong or curved shape. Prostatic stones are most readily displayed in lateral views, and the rays must be directed along the axis of the lesser pelvis, so that the shadow cast by the prostate will fall well within the ring of bone which the pelvis forms at this point.

Calculi may remain in the prostate for years without causing the slightest disturbance, to be demonstrated only when examination is made for some unrelated condition. Occasionally, however, extraprostatic stones are encountered, lodged directly in the prostatic urethra or in a communicating pouch. These are, in reality, urethral rather than prostatic calculi. Such stones may increase to a size sufficient to obstruct the vesical neck, producing a pathological condition akin to that of extreme prostatic hypertrophy. The value of simple roentgenography in conditions where it is impossible to pass a cystoscope is apparent.

**Roentgenography of the Urethra** Urethral stones, like bladder stones, are usually diagnosed cystoscopically or by physical examination, without resort to roentgenography, but the x ray is valuable in pointing out their precise location, as well as their size and conformation. Portable machines, which may be taken to the bedside or operating table, are especially useful in this type of work. Most urethral stones delineated upon the x ray film are encysted, since urinary calculi seldom remain lodged in the wider calibered urethra for any appreciable length of time.

**B RETROGRADE PYELO URETEROGRAPHY**

Retrograde pyelography—or, to be exact, pyelo ureterography—is the x raying of the ureter and renal pelvis after these structures have

been filled with a contrast medium injected through the ureteral catheter. This is, of course, a cystoscopic procedure.

### *Advantages and Indications Disadvantages and Contraindications*

Not every patient seen by the urologist requires a complete urological examination, and retrograde pyelography is not intended to be used as a routine procedure. It is not necessary where a complete and satisfactory diagnosis can be made without it, nor should it be used to corroborate perfectly evident conditions and findings.

The indications for pyelography will be considered in detail in the pages to follow. In general, retrograde pyelography is indicated when preliminary examination has disclosed pus in the urine, hematuria, or urinary disturbances such as frequency, urgency, nycturia and dysuria. Many urologists, confronted by these symptoms content themselves with doing an observation cystoscopy, being reluctant to subject their patients to the complete procedure. By so doing, they only too frequently overlook a pathological lesion of the upper urinary tract. As a matter of fact, retrograde pyelography has become so simple a procedure, once the catheters are in place, that under ordinary circumstances little or no additional distress is experienced by the patient from the injection of the opaque solution. The well known earlier dangers have been largely eliminated in competent hands, so that one is no longer justified in omitting or postponing this procedure when indicated for fear of potential renal damage and extension of infection.

The newer intravenous method has not displaced cystoscopy, ureteral catheterization, and retrograde pyelography as a diagnostic procedure. The retrograde method gives more information than does the excretory procedure, because the drug is injected directly into the kidney pelvis resulting in its proper distention. Moreover, its success is not dependent upon renal function. Another advantage of the cystoscopic method is that it permits the collection of urinary specimens from each kidney while the ureteral catheters are in position, and examination of the urine from the individual kidney is of the greatest importance in any disturbance of the urinary tract. No urologist would deem it advisable to remove a kidney without knowing definitely the function of its mate. Rarely will he perform nephrectomy on the evidence given by an intravenous pyelogram alone. While intravenous urography is a valuable auxiliary, it is a double expense to the patient, since retrograde pyelography must also be done, therefore, it should be used only when absolutely necessary.

The chief disadvantage of the retrograde method is that it is dependent

upon cystoscopy and is therefore precluded if, because of obstruction or great irritation, a cystoscope cannot be passed. Other conditions that may contraindicate the use of the procedure are acute illness or debility, low renal function, absence of one kidney, severe cardiac or vascular conditions that may make instrumentation dangerous, and uremic states.

### *Contrast Media*

Sodium iodide, sodium bromide, and thorium, formerly the most popular media for retrograde pyelo ureterography, have been displaced by newer and less irritating solutions such as skiodan, neo iopax, and diodrast. Neo iopax and diodrast may be purchased in 20 cc ampoules, which are broken open as needed, so that the solutions are always fresh.

### *Technic*

In doing retrograde pyelography it is our practice first to take two plain roentgenograms the patient lying on the table, with the cystoscope and opaque catheters in position but with no opaque medium injected. One film includes the kidneys and upper ureters, the other, the lower ureters and bladder. By this means, stones and foreign bodies in the urinary tract may be identified or eliminated, the outlines of the kidneys observed, and information obtained regarding their size, shape, location, and mobility.

After the plain roentgenograms have been taken, an opaque solution, such as skiodan, 20 per cent or diodrast, 35 per cent, is injected by means of a special ureteral syringe (15 cc graduated Asepto with Luer tip) through the ureteral catheter into the pelvis of the kidney to be pyelographed. As soon as the patient reports a feeling of fulness in the lumbar region, and a dull ache accompanied by slight pain the injection is stopped. A few drops of the solution are then allowed to flow out by releasing slightly the pressure on the hand syringe, and, when the patient is comfortable, the picture is taken. The sensation of fulness is caused by distention of the pelvis with the solution, and is to be anticipated. If too much pressure is exerted, however, great harm may result in a diseased kidney, or the patient may have so much pain that he will be unable to cooperate in the remainder of the examination. Ordinarily, 5 cc of the solution will suffice, but dilated pelvis and ureters often necessitate much larger quantities.

An exact way of determining the capacity of the kidney pelvis is to inject sterile water until the patient complains of slight fullness, and measure the amount removed by suction. A similar amount of opaque solution is then introduced. This eliminates the possibility of pain or of harmful distention of the pelvis. Another refinement is to introduce 1 to 3 cc. of a 2 to 4 per cent solution of novocaine or metycaine into the kidney pelvis and ureter following pyelography which usually eliminates pain.

After a picture has been taken with the patient in the supine position, he is raised to a semi-erect posture, his feet having been placed in the stirrups provided for that purpose. The catheter is then gently withdrawn, the solution being injected during its withdrawal, and a film taken immediately with the patient erect. A constant pressure must be maintained on the syringe during the injection and withdrawal. Films taken in the erect position reveal lesions which might not otherwise be detected particularly those associated with movable kidney.

The pyelo-ureterograms thus obtained completely outline the upper urinary tract, a most valuable aid in the diagnosis of any condition involving the urinary organs.

### *Complications*

The injection of the contrast solution may cause spasm and pain, which is sometimes acute but usually is a dull ache. This can generally be relieved by a hot tub bath and the application of heat to the kidney and bladder regions. If this does not suffice, 0.015 Gm ( $\frac{1}{4}$  grain) of morphine hypodermically, or 0.015 Gm ( $\frac{1}{4}$  grain) of pantopon, or 0.06 Gm of codeine should be given.

More serious complications are infrequent when pyelography is properly performed. Especially to be guarded against are over injection and the use of too much pressure. The pressure should not exceed 60 mm. of mercury because this pressure will be communicated to the glomeruli and tubules and will exceed the pressure in the capillaries causing a reverse filtration which will pass the medium from the kidney pelvis into the blood stream. If the solution used is toxic over injection can prove, and has proved fatal by causing a complete anuria.

Another possible, and avoidable, complication is traumatization by a too large catheter or one that is eroded and rough.

## C SERIAL PYELOGRAPHY

Pyeloscopy, or the fluoroscopic investigation of the upper urinary tract, though used by urologists for the past two decades or longer, is by no means an ideal method of visualization

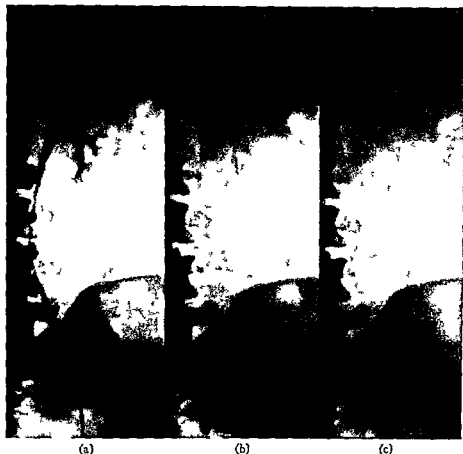


FIG 16 Serial pyelograms of left kidney showing normal emptying time (a) Immediate film, supine position The pelvis calyces and ureter are well filled (b) Three minute film (erect), showing 2½ per cent retention (c) Five minute film (erect) The kidney is practically empty

Jarre and Cumming, in 1930, presented an ingenious method of studying the emptying of the renal pelvis and ureter by the use of the cinex-camera, which permits the taking of 10 to 18 exposures in rapid succession following a single retrograde injection of contrast medium The expense of installing and operating the cinex-camera has prevented its common use

In 1931 Thomas D Moore described a simple, inexpensive, and prac

tical device for making serial pyelograms. This consists of a tunneled tray which is interchangeable with the ordinary Bucky diaphragm tray. By utilizing this apparatus, three exposures of a kidney and ureter can

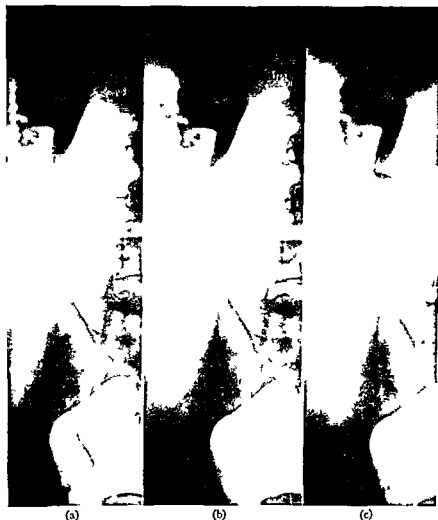


FIG 17 Serial pyelograms of right kidney showing delayed emptying time (a) Immediate film (supine) (b) Three-minute film (erect) (c) Five minute film (erect)

be taken on one 14 by 17 inch film. The entire series of exposures is made rapidly, to permit its being accomplished with but one injection of the contrast medium. The first and third exposures are made after exhalation and the second following full inspiration. Unless the patient is very fat, this can all be accomplished in 30 to 40 seconds. If the

emptying time of the renal pelvis and ureter is under investigation, a second series of exposures is made—usually at 5, 10, and 15 minute intervals

### *Technic*

At the Brady Urological Foundation, the technic for taking serial pyelograms, when delayed emptying is suspected, is as follows

The patient is instructed to take 45 cc of castor oil the preceding evening. Breakfast is omitted, and 400 cc of water is taken at 8 30 a m. The pyelograms are usually made at about ten o'clock in the morning. A No. 6 French ureteral catheter is introduced to the renal pelvis, and the pelvis and ureter filled with 20 per cent skiodan. A pyelo ureterogram is taken immediately, with the patient in the supine position. This is followed by films taken 3, 6, 9, 12, and 15 minutes later, the patient being in the erect position.

The series of films thus furnished enables one to differentiate physiological from pathological distortions and demonstrates the emptying time of the renal pelvis and ureter. Any definite amount of dye remaining in the renal pelvis on the 15 minute exposure is interpreted as delayed emptying.

### *Advantages of Serial Pyelograms*

Filling defects due to tumors or blood clots, renal or ureteral stones, or incomplete filling of the calyces, are demonstrated by serial pyelograms more accurately than is possible when only a single film has been exposed. The shadow of a stone in all three or six films is definite proof, as opposed to a mere possibility in a single film.

A non shadow casting obstruction in the ureter will appear in serial pyelograms as a constant defect in the ureter's normal outline. If partial stricture without stone formation exists, dilatation above the point of stricture will be evident on all the films. In those relatively rare instances where there are present stones (usually cystine) which are permeable by the x ray, the serial pyelograms will show the location of the translucent calculus which may later be demonstrated by use of the wax tipped catheter or by the passage of the stones themselves. In general, when an obstruction which is not sufficiently opaque to cast a shadow is shown to exist, it may be suspected of being a cystine stone, and the urine should be examined for cystine. Should cystine be found, the suspicion would be greatly strengthened, though additional proof would still be required.

Investigation of the ureter in cases of actual or suspected stricture is greatly facilitated by the use of serial pyelograms. The catheter no matter how skilfully manipulated is a foreign body. The ureter resents its introduction and being a duct possessed of peristaltic power it may exhibit this resentment by spasm when the wax tipped or other instrument is introduced. The examiner encountering resistance as he withdraws the catheter may interpret this hang as a stricture of considerable magnitude. Serial pyelograms taken when only the contrast medium is in the ureter (the catheter having been withdrawn) will do away with the danger of such misinterpretation. Not only a spasm but normal contractions of the ureter give one the feel of a hang.

Single pyelo ureterograms cannot be relied upon for the recognition of links, strictures, atony and certain other abnormalities of the ureter and ureteropelvic junction. Under normal conditions the renal pelvis and calyces are subject to systole and diastole and the ureter is subject to peristalsis similar to that observed in the intestinal tract consequently there is alternate constriction and relaxation of the ureter so that its outline is constantly changing. Multiple x rays taken during the emptying of the renal pelvis and ureter are necessary to distinguish physiological from pathological distortions.

In the study of hydronephrosis much may be learned from serial films regarding the location and nature of the obstructive factor. This is particularly true in early cases. These cases may show little or no evidence of pyelectasis but serial films will frequently demonstrate markedly delayed emptying. A hydronephrotic sac well filled with the contrast medium with constant absence of the dye in the upper ureter is indicative of some obstruction at the ureteropelvic junction such as an aberrant vessel which is incapable of casting a shadow that is visible upon the film.

Serial pyelograms are particularly desirable in the study of nephroptosis where the factor of constancy assumes great importance. If even a slight degree of motility of the kidney exists the taking of separate films for the different phases of respiration will immediately demonstrate this. The transient and asymptomatic nature of ureteral links occurring with nephroptosis has repeatedly been noted. Thompson and Bumpus have pointed out that many links at the ureteropelvic junction occur at the order to take a deep breath and hold it while the film is being exposed as the kidney descends with the diaphragm linking of the ureter takes place. On expiration however this linking may entirely disappear.



A permanently linked ureter is now known to be an exceptional condition, but in making retrograde pyelograms by the ordinary method, leaving the catheter in position "splices" the duct so as to keep it straight, while immediate withdrawal of the catheter permits a ureter attached to a ptosed kidney to relax into the kinked position which it occupied when the patient suffered a Dietl's crisis. Roentgen ray diagnosis of movable kidney by the serial method is therefore advisable, since it is by far the most accurate.

The study of renal mobility, or, rather, immobility, is also important in the diagnosis of perirenal abscess or perinephritis. Mathe has pointed out that very slight mobility, or entire absence of mobility, is often an aid in the diagnosis of these conditions.

**Determining Delayed Emptying of Pelvis and Ureter** The demonstration of delayed emptying time of the renal pelvis and ureter is helpful in deciding whether some pathological lesion, such as a kink or stricture, aberrant vessel, fibrous band or periureteritis, is interfering with adequate drainage. This is particularly true in nephroptosis and early hydronephrosis. It is our impression that renal mobility rarely causes pain unless there is interference with normal renal and ureteral peristalsis, resulting in urinary stasis, with or without infection. Nephropexy, therefore, is rarely indicated or beneficial unless stasis in a ptosed kidney can be demonstrated. The fact that transient ureteral kinks from renal mobility occur during inspiration, yet cause no renal pain, emphasizes the importance of proving inadequate drainage and urinary stasis before surgery is instituted (Nephroptosis. Diagnosis, p 1625).

There are numerous methods of demonstrating delay in emptying when renal pelvic retention is suspected. Excretory urograms are often satisfactory for demonstrating the delayed emptying time with marked obstructions, but a clear demonstration of the pelvis and calyces is rarely obtained in nephroptosis and early hydronephrosis. Fluoroscopic visualization of the urinary tract is difficult, and has not proved satisfactory for delineating the details of the calyces and ureters. Perhaps the simplest satisfactory method is to take an x ray 10 to 15 minutes following retrograde pyelography. However, the additional information obtained from a series of films taken at varying intervals, with the patient in both the supine and erect postures, warrants the selection of this method whenever possible.

**Normal Emptying Time of the Renal Pelvis and Ureter** The emptying time of the pelvis and ureter of a normal individual has been variously

estimated at from 2 to 10 minutes Goldstein (1921), by a study of fractional pyelo-ureterograms, estimated it at from 3 to 7 minutes, Herbst (1931), by pyeloscopy, determined it to be between 2 and 10 minutes Martinez (1927) stated that the rate of excretion of the contrast medium not only varies with individuals but also in the same individual from one moment to another

A study of 12 patients was conducted by Henline and Bray, at the Brady Foundation, to determine the normal emptying time of the pelvis, and ureter, and whether or not the fluid intake materially affects excretion of the contrast medium Each patient first had serial pyelograms following the ingestion of large quantities of fluid, and, about a week later, a second series, with fluids withheld Each required a shorter time to expel the contrast medium from the pelvis and ureter when fluids were forced, providing no obstruction was present The pelvis and ureter were free from contrast medium in 2 minutes in 2 patients with forced fluids, while the average emptying time was 4 minutes With restricted fluids, no renal pelvis was empty in 4 minutes and 9 patients still had some remaining medium in the upper urinary tract in 6 minutes From their study, these authors concluded that the normal emptying time of a kidney pelvis shows many variations, which may be dependent solely on the fluid intake, or on certain drugs, or even psychic disturbances, and that because of this variation, comparative serial pyelograms of each kidney, taken at the same cystoscopy, are preferable for the determination of delayed or imperfect drainage They further concluded that an arbitrary limit of 10 minutes should be sufficient for a normal kidney and ureter to empty, and that if bilateral serial pyelograms are made at one examination, the comparative study will demonstrate the presence, and usually the cause, of any obstruction which might be present

#### D INTRAVENOUS PYELO-URETEROGRAPHY

##### (EXCRETORY UROGRAPHY)

In this procedure, certain non toxic iodine compounds, injected intravenously, concentrate in the kidneys and are excreted into the ureters and lower portion of the urinary tract in sufficient quantity to cast an outline of the excretory tract in the roentgenogram

While urography does not usually give as clear-cut pictures as those obtained by the retrograde injection of opaque solutions, the circumstances permitting its use, when the older method is impossible or

dangerous, exist so often that its introduction must rank as one of the milestones in the perfecting of urological diagnosis

*Advantages and Indications Disadvantages and Contraindications*

Intravenous pyelography has not displaced cystoscopy as a diagnostic procedure, nor does its use in the ordinary investigation of the urogenital tract relieve the urologist from the necessity of taking a retrograde pyelogram when indicated. Retrograde pyelography is an anatomical method, while excretory urography is essentially a physiological procedure. It depends upon the excretion of the opaque medium into the calyces, pelvis, and ureters. Therefore, where kidney function is impaired the intravenous method may be misleading.

Excretory urography is invaluable in those cases in which cystoscopy or ureteral catheterization cannot be done. Ureters that have been transplanted into the bowel cannot be catheterized, and the same is true of strictured or otherwise obstructed ducts. Patients with these disabilities may be subjected to intravenous urography without harm and with the possibility of helpful information being obtained. It has also been of considerable help in the presence of obstructive congenital anomalies rendering cystoscopy mechanically impossible, with the result that congenital anomalies are being recognized more often clinically. It is well adapted to cases presenting obscure abdominal symptoms, and has frequently facilitated differentiation of abdominal masses, both intraurinary and extraurinary.

The intravenous method is of value in many cases of urinary tuberculosis. Most of these patients come to the surgeon for relief of the accompanying vesical irritation. This irritation makes cystoscopy so painful that general spinal, or sacral anesthesia is required. Also, the edema of the vesical mucosa which is always present, particularly in the region of the ureteral orifices, makes catheterization of the ureters difficult, if not impossible. In such cases the intravenous method is of the greatest assistance.

Excretory urography is also helpful in the detection of renal tumors, and in differentiating between stone in a calyx, a calcified cortical abscess, and an extraurinary shadow. Indeed, for the latter purpose the method is superior to any other because the structure of the renal cortex is accentuated in a manner not achieved by retrograde pyelography, and a tuberculous abscess in the cortex will stand out conspicuously. Other advantages of the intravenous method are: it offers a bilateral urogram at one examination, it is a fairly accurate barometer of total and relative

renal function it is of assistance in determining the presence of stasis in the ureter or renal pelvis it is simpler and less taxing to the patient it is less expensive (unless retrograde pyelograms must subsequently be done when the expense of examination is increased)

Intravenous urograms not infrequently fail to yield sufficient diagnostic information due to incomplete filling of the calyces or pelvis or to too rapid elimination of the contrast solution Retrograde pyelograms are usually preferable for the recognition of minor deformities which are less clearly delineated on the intravenous pyelogram Another disadvantage of the excretory method is the lack of cultural information

Although a simpler procedure than cystoscopy and retrograde injection this comparative simplicity of technic is offset by the greater experience required for interpretation Moreover in the very ease with which excretory urography may be practiced lie two of its chief dangers namely that it be used by incompetent men and that dependence be placed on it to an unwarranted degree

The greatest drawback of excretion urography is the fact that it is dependent upon approximately normal kidney function Crippled or functionless kidneys cannot excrete the intravenously introduced opaque medium into the urine in sufficient amount to give satisfactory outlines *This greatly limits the applicability of the method but despite these limitations it should never be overlooked in the diagnosis of abdominal conditions*

The combined use of excretion and retrograde urography will often yield more complete information than when either method is employed alone Because of the ease with which excretory urograms may be misinterpreted the findings can seldom be taken as final and must be carefully correlated with other urological studies Excretion urography and retrograde pyelography should supplement each other rather than compete for preeminence

Intravenous pycelography is contraindicated in (1) grave renal insufficiency (2) impaired liver function (3) iodine idiosyncrasy (4) hyperthyroidism though authorities differ regarding the use of the newer media in which iodine is rapidly eliminated (5) when the disorder of the urinary tract is complicated by a severe systemic disease such as active pulmonary tuberculosis

### *Pyelographic Media*

The solutions in most common use at present are neo iopax diodrast skiodan and hippuran

### *Preparation of the Patient*

About 24 hours preceding administration of the drug, the patient is given a dose of castor oil. Fluids are withheld for several hours prior to the examination, as fluid in the urinary tract dilutes the medium so that the roentgenograms will not serve their purpose. Therefore, if the examination is to be made at 9 o'clock in the morning, no fluids should be taken after midnight and no breakfast permitted.

### *Technic*

Two plain roentgenograms are taken before the injection is made. Twenty cc. of a suitable opaque medium, such as neo iopax, 20 per cent or diodrast, 35 per cent, is injected intravenously with an ordinary 20 cc. syringe if the patient is over 8 years of age (15 cc. if he is between 1½ and 8 years, 10 cc. if he is 1½ years or under). These preparations are supplied in 20 cc. ampoules, sterilized and ready for use.

A series of three x ray pictures is taken: the first, 5 minutes after injection (at which time there is usually evidence of the drug in the kidney pelvis), the second, 15 minutes after injection, and the third, 30 minutes after injection, when some of the drug may have advanced far down in the urinary tract. For the first and second pictures, the patient is in the supine position, for the third, in the erect posture.

It may be necessary to increase considerably the intervals between the taking of the pictures since excretion of the drug is dependent upon individual kidney function. Pathological conditions in the urinary tract will cause delayed appearance of the drug. In cases of impaired renal function, it may be necessary to take pictures many hours after the administration of the opaque medium.

### *Complications*

In our experience, no serious accidents have occurred in connection with the use of intravenous urography, and unpleasant after-effects have been transitory and slight.

## E SUBCUTANEOUS UROGRAPHY

Subcutaneous urography is rarely done when intravenous injection of the opaque medium is possible, but is a useful procedure when the intravenous method cannot be used either because of an uncooperative patient or because the vein cannot be located. Its use is confined almost exclusively to children.

*Technic of Subcutaneous Administration*

To 20 cc. of a 35 per cent solution of diodrast is added enough distilled water to make 100 cc of solution, about 50 cc. being injected under each scapula. Three pictures are taken, at intervals of 30, 60, and 90 minutes after the injection of the medium.

## F. PERORAL UROGRAPHY

*Contrast Media*

The possibilities of oral administration of pyelographic media were apparent to those who first utilized the intravenous method, but the use of the oral route had to await the development of a better tolerated and more quickly soluble contrast medium. Hippuran which is the trade name given to the sodium iodohippurate combination developed by Swick and Jaches in 1933 was the first and up to the present remains the only solution to have proved practical for oral administration. Its base is an iodine derivative of a substance normally found in human urine. It is distributed as a white powder, easily soluble in less than its own weight in water. It is well tolerated even by young children and by the aged and enfeebled. Used orally in clinical practice, it has given very satisfactory results, both from the standpoint of visibility of the upper urinary tract and the absence of reactionary symptoms.

The dosage is from 10 to 15 grams dissolved in approximately 75 cc of a mixture of simple syrup and elixir lacto-peptone. The only subjective sensation recorded is the salty aromatic taste of the solution and no nausea or vomiting has followed its ingestion.

The reason for the use of dextrose in perorally administered pyelographic media may require explanation. When intravenous pyelography was first put into clinical practice it was found that unsatisfactory urograms sometimes resulted because the contrast solution passed from the blood stream into the tissue fluids and also because the drug had such a diuretic effect that it was eliminated too rapidly from the portions of the urinary tract which it was particularly desired to visualize. It was necessary, therefore, to increase the hypertonicity of the contrast medium. Dextrose was thereupon introduced as its hypertonicity "hinders loss to the tissues and maintains a high immediate peak excretion" enabling one to secure good pictures within 15 minutes of its intravenous administration. By the oral route, a longer time must be allowed.

A disadvantage of peroral urography is this longer period of time

required for the securing of pictures, which makes it impractical for routine use in a busy clinic

### *Preparation of the Patient*

The preparation of the patient is the same as for intravenous pyelography (p 138)

### *Technic of Oral Administration*

From 15 to 20 grams of hippuran, dissolved in syrup, is given preferably in the early hours of the day. Saline aperients and all other salts should be ruled out during the entire period.

The best pictures are usually those taken about 90 minutes after oral administration of the drug. Deficient absorption will, of course, prevent satisfactory contrasts so that the oral method should not be used with patients known to have any alimentary tract irregularity. If only a cystogram is desired, however, the oral route will serve even with alimentary disturbance.

## G INTERPRETATION OF PYELO URETEROGRAMS

The value of urography is in direct proportion to the skill of the urologist in interpreting the films. This requires knowledge not only of the normal outlines but of deformities indicative of various anomalous and pathological conditions. Of especial importance is the ability to recognize earlier stages of disease. Certain deformities are characteristic of certain diseases, but, unfortunately, all urograms are not typical. It is only when deformities are clearly depicted, and typical of a certain pathological condition or anomaly, that diagnosis is possible on the pyelogram alone.

The urographic diagnosis of each of the lesions and anomalies mentioned below will be considered more thoroughly further on in these pages. The intention here is merely to indicate the chief renal and ureteral abnormalities demonstrable by pyelo-ureterography and their urographic appearances, where these are fairly typical.

**Normal Renal Pelvis and Ureter** There is considerable difference of opinion as to what constitutes normality in a kidney pelvis.

In the roentgenogram, the right pelvis should be shown as lying from 3 to 5 cm. below the left. If this relation is not maintained, the inference is that some abnormality, either a congenital malformation or a pathological condition, exists.

If one kidney shadow is materially larger than the other, even if there is no roentgenographic evidence that one organ is not functioning, *compensatory hypertrophy* should be suspected, and further investiga



FIG 18 Bilateral retrograde pyelogram (adult female) The left side is normal. The minor calyces on the right side are slightly dilated but retain their normal cupping

tion should be made of the relative function of each kidney. In retrograde pyelography the normal pelvic capacity is reckoned at about 8 cc, though a large but not otherwise abnormal pelvis may hold as much as 20 cc



While there are usually but three major calyces, there may be two or even four without any other noticeable deviation from normal form, and the minor calyces may vary in number from six to fifteen. The calyces should show a clear cut cupping, with no shagginess or dulling of the outline and no bulging or narrowing of the infundibula. The upper major calyx is usually long and slender, the lower, shorter and thicker.

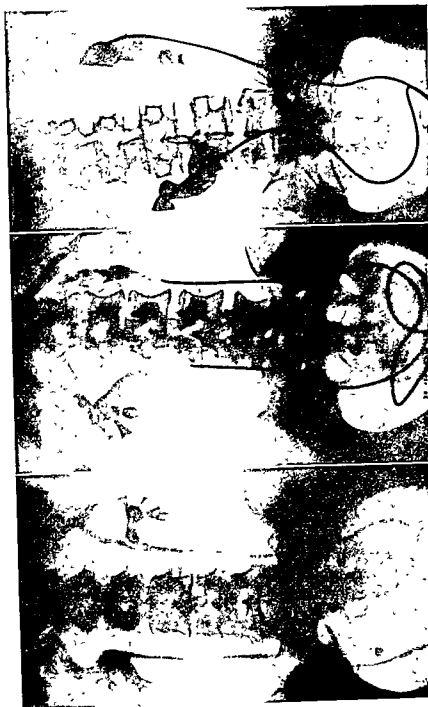
The normal renal pelvis is generally triangular in outline or funnel shaped. The base of the triangle is parallel with the long axis of the kidney, while the apex points downward and leads into the ureter. This outline may, however, vary considerably while still keeping within normal bounds. One should expect to find both kidneys generally similar in outline. Marked divergence is suggestive of an anomalous or pathological condition.

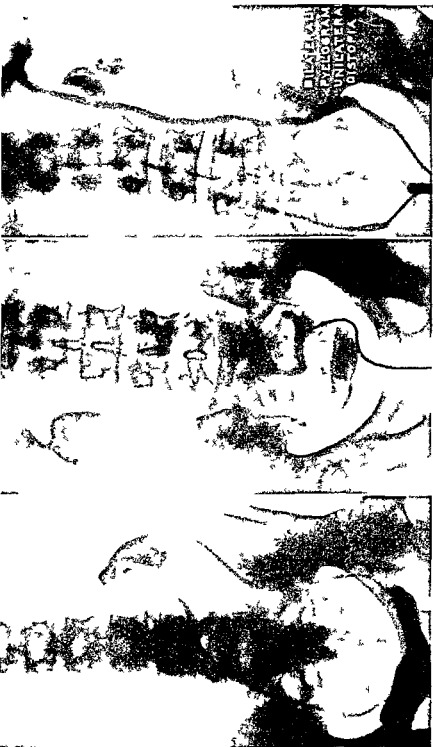
In adults, the ureter averages about 4.5 to 5.5 mm. in diameter when distended. Its outline is quite uniform except at its normal points of constriction, namely, at its entrance into the renal pelvis in the center of the abdominal portion, and at the ureterovesical junction. The diameter may, however, vary considerably with the size of the individual, this variation ranging all the way from 1 to 7.5 mm.

*Peristaltic Contraction of the Ureter* An entirely normal condition, which must be rightly interpreted when observed is peristaltic contraction of the ureter, a long constriction which does not appear in two successive plates. This is a well recognized condition, and not likely to be mistaken for a ureteral stricture, which never occurs over such a wide portion of the duct and in successive pyelograms is always in a fixed position.

*Anomalies of the Kidney and Ureter* Congenital anomalies of both the kidney and the ureter are relatively common and may take many different forms (Figs. 19 and 20). They occur more often in the male than in the female. Anomalies of the kidney can be visualized in only two ways by operation and by pyelography. As anomalous kidneys are much more subject to disease than normal ones it is perhaps not surprising that so many malformed and misplaced kidneys are discovered during examination for some urinary tract disturbance for which they may or may not be responsible.

*Anomalies of Number and Form* The simplest malformation of the kidney is *duplication of the pelvis*, which is quite common and easily recognized in the pyelogram. Duplication may be partial or complete. "Double" pelvis may mean merely an elongation of the normal upper





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FIG 19 Congenital anomalies of the kidney and ureter (retrograde pyelo ureterograms) (1) Simple bifid renal pelvis (left) with branch ing in the ampulla and upper part of the ureter (2) Hypoplastic left kidney The pelvis is rotated on its long axis The kidney on the opposite side is larger than normal (3) Bilateral pyelo ureterogram showing typical appearance of a horseshoe kidney (4) Unilateral fused kidney on the left side The calyces point inward (5) Left ectopic kidney lying directly over the body of the sacrum The ureter is much shorter than that of a normally placed kidney (6) Crossed renal ectopia Cystoscopically, there is no indication of abnormality as the ureters enter the bladder normally



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FIG 20 Congenital anomalies of the kidney and ureter (retrograde pyelo ureterograms) (1) Complete bilateral duplication of the pelvis and ureters Cystoscopically, four ureteral orifices were observable in the bladder (2) Three ureters and pelvis on one side The third pelvis is injected with sodium iodide (3) Complete unilateral duplication of the pelvis and ureter (4) Double renal pelvis and bifid ureter (left) On the inferior aspect of the sacrospinous junction the two ureters join to form a single outlet into the bladder At this junction there is definite constriction, causing back pressure and dilatation of both ureters and pelvis (5) Bilateral double pelvis and bifid ureters with hydronephrosis and a large branching calculus in the left lower pelvis On the right side the ureters unite at the level of the fifth transverse process, on the left, at the level of the third interspace Cystoscopically, there is no indication of anomaly as two ureteral orifices in normal position appear at the sides of the trigone (6) Same case I lat plate showing large branching calculus in left lower pelvis

calyx or two entirely distinct functioning pelves. In rare instances, as many as three distinct pelves have been demonstrated. Double pelvis often exists in conjunction with a normal ureter. Occasionally two pelves with wholly distinct ureters will be demonstrated in the pyelogram (Anomalies of the Kidney, p 1365, Anomalies of the Ureter, p 1215).

There are many different types of *ureteral duplication* upright Y, reversed Y, two lumina in a single sheath, etc.

A few cases of *crossed ectopy* have been reported. In this curious anomaly the ureteral orifices are apparently normal, but the ureters instead of going normally up and down, cross in such a way that the ureter from the right kidney enters the bladder on the left side of the trigone, and vice versa.

Most of these anomalies are easily distinguished on *pyelo ureterograms*—either retrograde or intravenous.

A *double kidney* is a further extension of the duplication process and occurs fairly often. This type of kidney appears to be more subject to pathological changes than the normal organ, the lower portion of the double kidney being the one usually affected.

*Horseshoe kidney* is but one type of fused kidney although it is the type most often encountered. It may be recognized by the fact that the calyces extend mesially to the descending ureter, a characteristic and invariable picture. Fused kidney may be discerned in a plain roentgenogram because both pelves will be nearer than normal to the spinal column and will be about equal in height and angle of inclination. If a unilateral pyelogram has been made, and the pelvis is observed to be abnormally near the vertebrae, the existence of a fused kidney may be inferred from this alone. Intravenous injection gives the best representation of the condition in those cases where the function of both sides is approximately normal, the presence of the contrast medium in the secreting portion of the renal parenchyma being helpful in displaying the anomalous conformation. If one side is badly diseased the retrograde method, or even the plain roentgenogram, must be relied on.

*Unilateral fused kidney* is occasionally encountered, but must be reckoned a rare anomaly. Its existence may be determined by the location of both, or all three, pelves on one side, with no kidney shadow on the opposite side in the renal area. The diagnosis must, however, be confirmed by cystoscopy, and the plain roentgenogram should be of assistance.

*Congenital stricture of the ureter* is well demonstrated on the pyelo-

ureterogram While most common at the ureteral orifice, a congenital stricture may occur at any point in the ureter's extent Stricture at the orifice causes the ureter to dilate and protrude into the bladder, the resulting ureterocele being plainly evident in the ureterogram

*Anomalies of Position* *Ectopic kidney* presents an interesting pyelographic subject The ectopic mass can sometimes be felt by the palpating hand, but more often the kidney is only made out by retrograde or intravenous pyelography

While ectopic kidney is a relatively prevalent congenital anomaly, the majority of displaced kidneys are of the acquired type *Nephroptosis* may be due to the weight of a growing tumor, disorganized abdominal pressure, torsion or weakening of the renal attachments, or simply to loss of the supporting fat upon which the kidney depends for the maintenance of its normal relations to surrounding organs Nephroptosis is one of the commonest conditions confronting urologists It is well to remember that the right kidney is the one more often affected, and that the condition is far more common to women than to men Bilateral ptosis is not uncommon The ptosed kidney is a likely subject of urinary infections and other pathological conditions

Nephroptosis is clearly demonstrated in pyelo ureterograms taken with the patient in both the supine and erect positions By this method a clear outline is obtained not only of the descent of the kidney but also of the ureteral distortion usually present Serial pyelograms are especially valuable in the diagnosis of this condition The roentgenographic investigation should be very thorough, as temporary alterations in the conditions are common

*Hydronephrosis* Hydronephrosis is distention (in greater or less degree) of the renal pelvis and calyces with retained urine, the evacuation of which has been prevented by some mechanical obstruction at the ureteropelvic junction, in the ureter, or in the lower urinary tract, or by a neuromuscular dysfunction of the ureter or pelvis

Retrograde and excretory urograms are both useful for demonstrating well established hydronephrosis, but early changes are not satisfactorily visualized on the excretory urogram Serial pyelograms are particularly valuable in the study of hydronephrosis Obstructions at the ureteropelvic junction and delayed emptying of the pelvis and ureter, two very important factors in hydronephrosis, are better studied by this method than by any other

*Ureteral Stricture and Kinks* Without a complete history and careful



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FIG. 21 Strictures and kinks of the ureter (Retrograde pyelo ureterograms) (1) Marked hydronephrosis and hydro ureter (left) in a 27 months-old infant due to stricture at the ureterovesical junction. There is also a distortion at the ureteropelvic junction (2) Stricture at the ureteropelvic junction (left) (3) Hydroureterosis caused by constriction and kinking of the ureter at the ureteropelvic junction (4) Shaped kink of the left ureter at the lower level of the sacrum with a narrowed area at the base of the loop which suggests a stricture. This patient had a complete hysterectomy with removal of both ovaries one year previous to pyelography (5) Kinking of the right ureter due to marked ptosis of the kidney (6) Kinking of the right ureter at the ureteropelvic junction caused by first degree ptosis of the kidney chronic pyelonephritis

correlation of physical findings, the interpretation of uretero pyelograms, when stricture is in question, will not be very satisfactory To quote Wesson "The diagnosis is not warranted unless the film reveals above the suspected area a definite pathological dilatation " It is probably nearer the truth to say that we *infer* the suspected stricture from what we can observe of its effects, rather than that the urogram or plain roentgenogram actually demonstrates the stricture itself Serial pyelograms serve best for the interpretation of ureteral stricture

Serial pyelography is also the best method of studying ureteral kinks These usually occur in the upper portion of the ureter near its junction with the pelvis The majority of ureteral kinks are transient and produce no symptoms If the kinking of the ureter is rendered constant by the presence of adhesions or other abnormalities, marked interference with urinary drainage may result This factor of constancy or transiency, which is so important in the interpretation of ureteral kinks and constrictions, is admirably demonstrated on serial films

**Renal Infections** Patients suffering with acute infections of the kidneys are not usually subjected to pyelography during the acute stage, and it is therefore difficult to describe the appearance of a pyelogram or ureterogram of such a case Pyelography is customary however, in chronic infections and the pyelograms in such cases are often very interesting and sometimes quite characteristic

The gonococcus rarely invades the kidney and gives no characteristic pyelogram The colon bacillus, the commonest invader of the upper urinary tract, usually presents a characteristic pyelographic picture It is practically always present in hydronephrosis and causes a blunting of the normally sharp outlines of the renal pelvis and calyces giving them a fuzzy or moth eaten appearance which while not so marked as that seen in tuberculosis, nevertheless is quite distinctive When the *Staphylococcus aureus* or the streptococcus in any form invades the kidney the patient is usually much more toxic and the urographic picture is not characteristic

**Renal and Ureteral Tuberculosis** The diagnosis of renal tuberculosis is discussed more fully on page 1500 Certain factors should however be borne in mind in connection with the roentgenographic diagnosis The incidence of the disease is about equal in males and females While the clinical lesions of renal tuberculosis are originally unilateral in most cases, a considerable percentage later become bilateral In any roentgenographic investigation, therefore, both sides should be carefully

examined, irrespective of whether or not nephrectomy is contemplated. The disease often appears in middle or late life, which is contrary to the pulmonary manifestations, which are regularly seen in young adults.

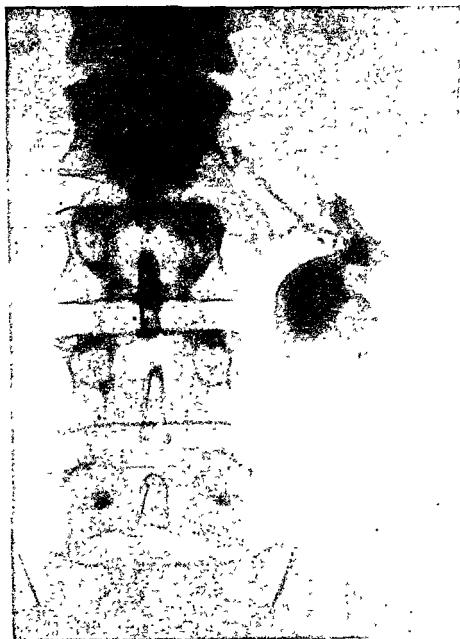


FIG. 22. Pyelogram (left) showing chyluria.

Thus, the mere fact that a patient is in his forties or fifties should not lull one's suspicions of the tuberculous nature of his ailment. Though the patient may be quite unaware that he has ever been infected with pulmonary tuberculosis, examination of the lungs will frequently show healed foci or the relighting of old, long-dormant areas.

Both the retrograde and excretory methods are of the greatest usefulness in the diagnosis of renal tuberculosis. The vesical irritation that often accompanies the kidney lesion sometimes precludes cystoscopy, and the intravenous method has frequently proved a great boon to the physician under these circumstances. Intravenous or peroral introduction of the medium is innocuous, but where the kidney is functioning poorly, or not at all, is useless so far as the diseased organ is concerned. However, when the plain roentgenogram has shown outlines suggestive of tuberculous infection of one side, the information that excretory urography can give concerning the sound side will be of help in many ways. If the plain roentgenogram's evidence is doubtful, and it is possible to pass a cystoscope, retrograde pyelography with one of the newer media will not endanger the patient and may prove invaluable. In 9 cases out of 10 tuberculosis can be excluded if the pyelogram thus obtained proves negative. Functional tests and estimation of the amount of pus in the urine can only suggest conditions which the pyelogram positively demonstrates. When employing the retrograde method, stereoscopic films will be found of greatest value.

*Early Pyelographic Appearances* A condition of toxic nephritis or pyelonephritis may early be induced by the presence of tubercle bacilli in the kidney. This must be differentiated from similar conditions due to other causes. Before there are any demonstrable lesions in the parenchyma of the kidney, the presence in the urine of tubercle bacilli, and the occlusion of the calyces and pelvic outlet which they cause, will be productive of some degree of distortion in the outline of the pyelogram. However, unless the process extends rapidly, the presence of the tubercle bacilli will not be betrayed by any noticeable degree of enlargement. Intravenous pyelograms made at this stage will show that the affected kidney is functioning poorly. Wesson and Ruggles state that the initial infection is sub-epithelial in the papillae of the kidney, close to the point of reflection of the mucous membrane of the minor calyces, or at the base of the pyramids. When the infection breaks through the epithelial lining, it leaves an irregular moth-eaten surface, this is the earliest pyelographic proof of renal tuberculosis and is usually found in the

superior calyx This evidence of cortical necrosis is typical of tuberculosis, and, when associated with tubercle bacilli in the urine, is diagnostic

*Later Manifestations* Fibrous attempts at repair, with caseation and the formation of cavities, are later manifestations, and are plainly



FIG 23 Pyelovenous backflow (left) Retrograde pyelo-ureterogram

visible on pyelo ureterograms taken at this stage of the disease Still later, wide areas of infiltration are to be seen The ureter becomes strictured, with resultant hydronephrosis Irregular dilatation of the ureter, accompanied by incomplete filling, is almost conclusive evidence in favor

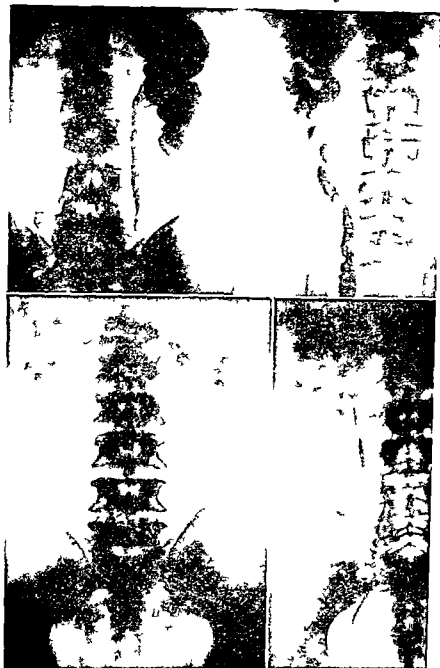


FIG. 24. Tuberculosis of the kidney and ureter. (1) Chronic tuberculosis of the left kidney and ureter. Most of the kidney has been destroyed; only the outer shell of kidney substance remaining. (2) Renal tuberculosis with ureteral involvement. Note the characteristic moth-eaten appearance of the ureter and calyces. (3) Bilateral calcification in tuberculous kidneys. This patient also had bilateral ureteral calculi. (4) Marked tuberculous fibrosis and chronic inflammation of the kidney. Note the rigidity of the ureter.

of tuberculosis as opposed to inflammatory conditions due to other infections. The "areas of feather edged destruction," mentioned by Wesson, become more prominent as the disease progresses. Frequently, only a minor calyx is affected, again, a major calyx may have a tuberculous stricture in the infundibulum, practically isolating it, and sometimes all the calyces, as well as the pelvis and ureter, are involved. The hydronephrotic sac represents the final stage. As the kidney is now entirely functionless, intravenous and peroral methods are useless.

*The caseation and calcification of renal tuberculosis must be differentiated from stones, calcified glands outside the kidney, calcified cysts, and tumors.* Subdiaphragmatic and perinephritic abscesses may also cause confusion. Carbuncle of the kidney is not likely to cause difficulty in diagnosis if there is already suspicion of tuberculosis.

**Cystic and Solid Tumors of the Kidney and Ureter** Both cysts and solid tumors are relatively common in the kidney. Any form of new growth of the ureter is uncommon, and cysts are so rare as to be of slight clinical importance in routine urological practice.

*Congenital polycystic kidney is proving a more common lesion than was formerly believed, and its recognition by means of x ray investigation has been of great assistance in establishing this fact.* In polycystic disease, the appearance of the pyelogram varies with the stage of the disease. In the later stages it often simulates renal neoplasm. The changes consist chiefly in alterations due to compression of the calyces by the cysts. As a rule, there is narrowing of the pelvis and elongation of the calyces, so that they extend over a space larger than the usual renal area.

When a large solitary cyst is present, the urogram may be normal, or it may show evidence of pressure or pulling on the pelvis or calyces, together with ureteral distortion and change in the position and axis of the kidney as a result of the weight of the mass.

In cystic tumors, the outline of the kidney or psoas muscle, or both, will be recorded on the x ray film through the shadow of the cyst, which is of lesser density.

A rare cystic condition seen in the kidney is echinococcus disease (hydatid cyst).

In the diagnosis of renal neoplasms, pyelography offers the most useful means at the urologist's disposal. In these cases cystoscopy is of little value and clinical evidence usually very meager. Hematuria may be the only constant sign, and this is indicative of many other urinary tract lesions.



3



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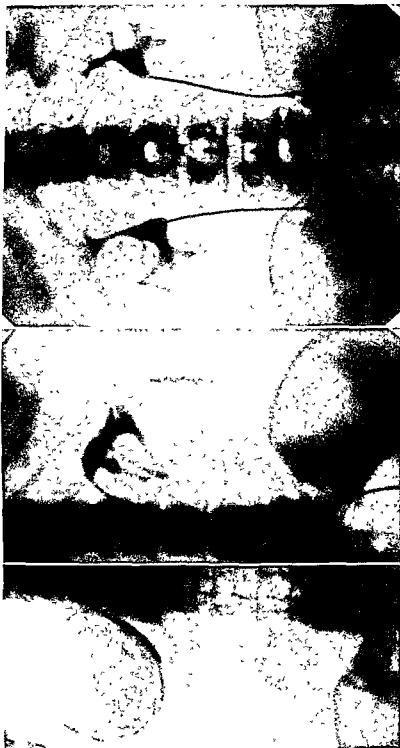


FIG. 25. Cysts of the kidney. (1) Bilateral polycystic kidneys. (Left) A typical polycystic kidney. (Right) Double polycystic kidney. The catheter is in the ureter to the lower half of the double kidney. Note small shadow, apparently a stone, in the ureter of the upper half. (2) Polycystic left kidney. There is narrowing of the pelvis and elongation of the calyces, so that they extend over a larger space than the usual renal area, a common finding in polycystic disease. (3) Large solitary cyst of the right kidney. Below the kidney, and overlying its lower pole, is an area of increased density which extends almost to the iliac crest and mesially to the edge of the spinal column. The kidney being otherwise healthy, the cyst, which was approximately 13 by 12.5 cm. was resected. (4) (For differential diagnosis) Calcification in the liver (flat plate). (5) Huge multilocular cyst of the left kidney in a 57-year-old female. The kidney, with the cyst, was successfully removed. The cyst weighed 905 grams. (6) (For differential diagnosis) Echinococcus cysts of the liver.



3



2



1



FIG 26 Tumors of the kidney (1) Huge adenocarcinoma of the right kidney, which has compressed the pelvis and displaced the pelvis and ureter up ward and mesally. Irregularity of the lower calyx and the inferior pelvis indicates the probable origin of the tumor at this point (2) Hypernephroma of the left kidney in a 16-year-old female (confirmed). Note marked enlargement and distortion of the pelvis. Kidney shadow also is a calcified area. Ninety five per cent of the removed kidney mass consisted of tumor tissue (Case of Dr Vincent A. Nardello) (3) (For differential diagnosis) Large extra renal hematoma probably due to rupture of infarct of kidney (4) Papillary carcinoma of the renal pelvis involving the entire lower pole of the kidney (5) Papillary carcinoma of the renal pelvis (left) Excretory urogram (15 minutes) (6) Same case Postoperative specimen (Kirwin's case)

Pyelography will quickly show whether or not a kidney is normal, but, as there are probably no two tumors which distort the kidney in precisely the same way, exact diagnosis by this means alone is impossible. There are, however, certain deformities which, though common to other pathological conditions as well, are strongly suggestive of tumor if several are demonstrated simultaneously in the pyelogram. These are (1) enlargement of the entire kidney shadow, (2) elongation or enlargement of the renal pelvis, (3) distention or retraction of one or more calyces or of the entire pelvis, (4) a filling defect of the pelvis caused by invasion of the lumen, (5) displacement or rotation and abnormal position of an otherwise normal pelvis, (6) overlapping of the vertebrae by the distorted ureter, (7) deformity of the ureteropelvic junction and upper ureter, indicating encroachment by a mass.

Unfortunately, early neoplasia in the kidney gives slight or no pyelographic evidence. However, one who is thoroughly experienced in the interpretation of pyelograms may sometimes be able to make a diagnosis even when the tumors are very small or when there is as yet nothing more than malignant ulceration of the kidney pelvis.

The earliest deformity which can be attributed to renal tumor is elongation of one or several of the calyces. The lumen of the affected calyx is usually contracted at the same time, and there is often, though not always, considerable general distortion of the adjacent pelvis. As the length of the calyces varies considerably even in normal kidneys, this alteration must be well marked before it can be positively termed indicative of neoplastic growth. 'Spider leg deformity' is the term usually applied to the marked spreading elongation and enlargement which long experience has taught roentgenologists who follow their cases to the operating room or autopsy table to be characteristic of tumor.

Practically all renal neoplasms eventually encroach upon the pelvis, so that the pelvic outline is invariably irregular except in very early cases. In pushing in the cavity of the pelvis, as Waters has pointed out, a renal tumor will often leave a thin compressed cup like extension of the pelvis about the periphery of the tumor mass. In more extensive growths the pelvis may be reduced to a thin leaflet, scarcely casting a shadow except where it presents itself at a tangent to the rays.

These appearances must be distinguished from the enlargement of the calyces typical of tuberculosis, from the very irregular pelvis of pyogenic infection, and from the elongated, complicated arrangements in congenital polycystic kidneys. The size and weight of a tumor may cause changes

in the course and outline of the ureter strikingly like those commonly associated with the clinical characteristics of movable kidney. Due to the position of the retroperitoneal lymph glands, enlargement or new

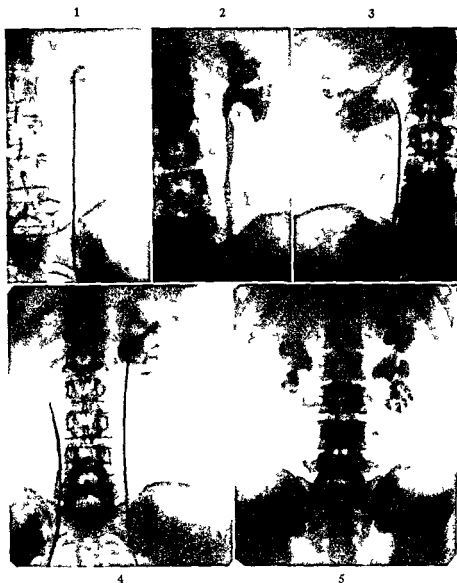
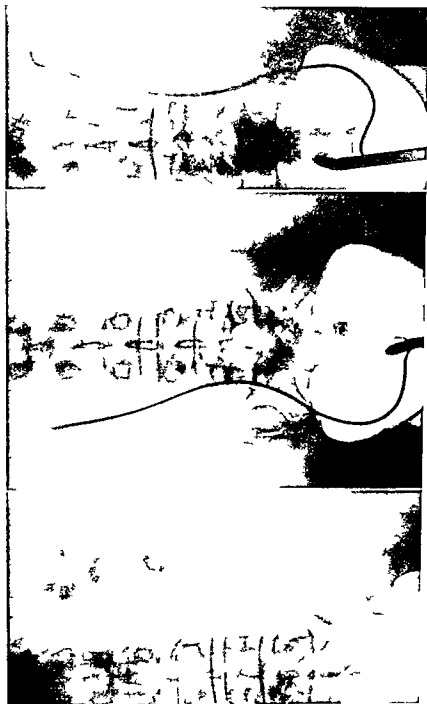


FIG 27 Renal and ureteral calculi. (1) Flat plate showing large solitary calculus in the region of the renal pelvis on the left side. (2) Same case. Retrograde pyelogram. A large stone occupied the renal pelvis incompletely blocking the urinary outflow. The pelvis is small but there is dilatation and blunting of the calyces. (3) Retrograde pyelogram. Large staghorn calculus with pyelonephritis and abscess formation (confirmed). (4) Retrograde pyelogram. Negative calculus composed of uric acid. Note filling defect. (5) Flat plate. Huge bilateral staghorn calculi and numerous smaller stones (cystine) in a young man 18 years of age.



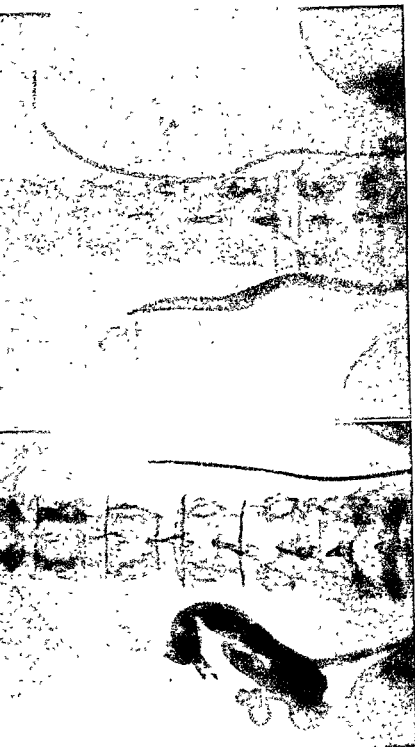


FIG. 28. Renal and ureteral calculi. (1) Unusual distribution of calculi in pyonephrotic left kidney. (2) Calcium oxalate stone in ectopic left kidney. (3) Small stone in the intramural portion of the left ureter. (4) (For differential diagnosis) Stones in the gall-bladder. This patient had pain in the right upper quadrant. The flat plate showed stones in the region of the right kidney pelvis. Pyelography proved the stones to be extra-urinary. (5) (For differential diagnosis) An appendectomy failed to relieve the right-sided pain in this 18-year-old female. She was cured by a nephrectomy necessitated by destruction of her right kidney due to a tightly wedged stone at the ureteropelvic junction.<sup>7</sup>

growth of these structures is frequently confused with renal tumor. Pyelography is particularly useful for ruling out extrarenal conditions such as perinephritic abscess and tumors and abscesses in neighboring organs and in the distinguishing of cysts from solid tumors of the kidney.

If possible combined intravenous and retrograde pyelography should be utilized in all cases of suspected renal neoplasm. As the fate of any kidney containing a new growth is regularly removal every diagnostic means should be exhausted in establishing a positive diagnosis.

**Renal and Ureteral Calculus** Stones may form at any point in the urinary tract but the majority probably originate in the kidney and are carried downward with the outflow of urine. Once started on their course any one of numerous possible factors may decide where they will eventually lodge.

The clinical symptoms of stone in the kidney or ureter may be ascertained by reference to pages 1261 and 1602. The appearance of such manifestations should prompt the physician to institute immediate x ray exploration for with the roentgenographic means now at our command more than nine tenths of urinary stones can be discovered irrespective of their location. Plain roentgenograms are usually helpful in demonstrating stones of the kidney and ureter but pyelography is much the more satisfactory means. The retrograde method however is necessary in most cases as stone formation so frequently lowers the function of the affected kidney that the intravenous method is not satisfactory.

The entire conception of urinary stone as a clinical entity was changed by Roentgen's discovery. From the beginnings of medical history the existence of stone was known to be accompanied by symptoms of the most violent and alarming description. What was *not* known was that stones can and do exist without producing any symptoms whatever. It is now well realized that stones may form in a kidney in such numbers as practically to destroy it without the unfortunate victim being aware of their presence or suffering symptoms sufficiently distressing to make him seek medical advice. It is in the demonstration of such silent stones that roentgenography has rendered one of its greatest services to urology.

Because the pelvis is the most common location of renal stones the possibility of small silent stones being lodged in a calyx is often overlooked. Stones in the calyces frequently become encysted when they have formed at the tip of a minor calyx and so injured the mucosa as to



cause cystic degeneration of that portion of the kidney. Some cysts may arise because the stone, as its size increases, cuts off the drainage from the calyx; or the drainage may be cut off by some other agent and the stone forms in the resulting cyst.



FIG. 29. Traumatic rupture of the right kidney. The pyelogram shows definite irregularity and abnormal appearance of the pelvis and calyces

Occasionally, there may be a single stone in each kidney, with all the symptoms referred to one side. A pelvis may be packed with multiple tiny stones, or a number of small stones may coalesce to form staghorn or other bizarre-shaped calculi.

The excruciating pain called "renal colic" is sometimes caused by blocking of the ureter by a blood clot or by ureteral obstruction from some other cause, such as the kink caused by nephroptosis, but the most common cause of such blockage is stone. Impacted calculi at the ureteropelvic junction and stones lodged in various parts of the ureter are common.

*Stone in Conjunction with Other Abnormalities* Stone formation may accompany almost any other pathological condition to which the kidney is subject. Stones are sometimes the direct result of injury or disease of organs outside the urinary tract—for example, trauma to the spinal cord, peptic ulcer, extensive burns, or infections of the mouth and sinuses.

*Traumatic Injury* *Surgical Injuries to Ureter* Injury to one or both ureters is sometimes accidentally inflicted during extensive pelvic procedures such as panhysterectomy. The ureter may be nicked, permitting escape of urine into the periureteral tissues, it may be completely severed, or it may be included in a ligature, so that its lumen is partially or completely occluded. Any one of these accidents is readily demonstrated by intravenous pyelography in subjects whose kidneys are functioning normally.

*Rupture of the Kidney* In the demonstration of kidney injuries, urography gives valuable information not only as to the injured kidney but also regarding the function of its mate. Frequently, in these cases, the patient's condition will not permit cystoscopy and retrograde pyelography. Excretion urography must, therefore, be relied upon.

*Ureteral Diverticulum* Ureteral diverticula may be either congenital or acquired. The congenital form is a sac or pouch along the course of a relatively normal ureter and is probably an abortive attempt on the part of nature to develop a bifurcation or a supernumerary duct. Acquired ureteral diverticulum is usually due to stone, which, in turn, often forms because of a stricture above which salts collect and form a concretion. If the ureteral wall just above the point of stricture happens to be weak, or actually defective, it will give way before the increased pressure of urine collected above the stricture. Because of the elasticity of the ureteral wall it stretches instead of rupturing. The side of the stone opposite the diverticulum is sometimes channeled so that urine is able to flow down the ureter in practically normal amount and frequency. When this occurs, the pelvis and calyces may be but little larger than normal, indicating that only slight obstruction has been caused despite the size of the stone.

There is no way of determining, pyelographically, whether such a pouch is congenital or acquired. Microscopic examination of the tissue would be the only positive means of identification.

## H RENAL ARTERIOGRAPHY

Renal arteriography is the roentgenographic study of the renal circulation made visible by the injection of a contrast medium into the aorta. According to the technic of Dos Santos, who first described the method, this is accomplished through a long needle inserted into the back at the level of the twelfth dorsal and second lumbar vertebrae. In 1931, Dos Santos stated that he had punctured and injected the aorta in more than 300 living subjects without a single accident. We have had no personal experience with the method but are inclined to agree with the opinion of Henline and Moore (1936) who, following a series of experiments on dogs, in which they utilized various solutions including sodium iodide, skiodan, iopax, thorotrast and uroselectan B, came to the conclusion that the danger of aortic arteriography, in its present stage of development at least, is too great to compensate for the information obtained from the x ray film—information which is ordinarily obtainable through simpler and less hazardous methods. The chief dangers of the procedure are hemorrhage and the toxicity of the contrast solution and extreme care must be exercised in the puncturing of the aorta and in the selection of the contrast medium.

## I PNEUMOPERITONEUM

Urological diagnosis has in the past sometimes been expedited by the injection of air or gas into the peritoneum while the patient is kept under fluoroscopic observation. The introduction of excretory urography has made the employment of this method unnecessary, and the fact that the maneuver can only be carried out by experts under perfect hospital conditions greatly limits its usefulness.

## J EXCRETION UROGRAPHY AS A MEASURE OF RESIDUAL URINE

It was suggested in 1935 by the English urologist Kenneth Heritage, and more recently in this country by Edwin Beer, that a contrast medium, administered either intravenously or orally, is a useful means of gauging the amount of residual urine in cases of bladder neck obstruction. This can only be done, however, when renal function is adequate—a restriction which makes the method inapplicable in many prostatic cases.

The chief advantage of the procedure is that the estimating of the residual urine may be done at the same time as the regular urographic examination thereby eliminating the necessity of catheterizing the bladder. The passage of a catheter to draw off the residual urine entails the risk of introducing infection into the bladder and in addition is ill tolerated by many patients. It is customary in intravenous urography to have the patient empty his bladder before the last urogram is made; therefore the amount of residual urine will be shown upon the film or fluoroscopically without the expenditure of extra time and effort.

The advantage claimed for this method is that while it does not of course give precise measurements the trained observer can gauge fairly accurately the amount of residual urine without exposing the patient to the dangers of trauma or infection. We do not feel that such estimation is accurate enough and do not advocate its use.

#### A. CYSTOGRAPHY AND URETHROGRAPHY

An x ray picture of the bladder taken after the viscus has been filled with an opaque medium is called a *cystogram*; a similar picture of the urethra is called a *urethrogram*; and a picture of both the bladder and urethra on a single film is termed a *cysto urethrogram*.

The first really efficient cysto-urethrograms were made after the injection of an opaque medium (lipiodol) into the urethra and bladder, and this method is still standard. Since the introduction of the excretory method however the popularity of the injection technic has declined somewhat. These newer methods of administration are simpler and easier but considerably more time is required between the administration of the opaque medium and the making of the x ray or fluoroscopic examination and the pictures are not always as satisfactory.

#### *Contrast Media*

Opaque media for cystography and urethrography have not been standardized. Sodium iodide, hippuran, umbrathor, lipiodol and iodochloral are perhaps the more popular media in present use.

*Sodium iodide* 2 to 10 per cent is probably the cheapest and most generally satisfactory medium for clinical use in making cystograms. Considerable care and judgment are necessary in making up the solution for if it is too dense it will obscure foreign bodies and stones. We use a 10 per cent solution of sodium iodide when taking cystograms for the demonstration of diverticula and a 3 per cent solution for cysto-urethrograms and for vesical tumor.

*Hippuran jelly* is a very satisfactory contrast material for urethrog-raphy. The formula as used at the Brady Foundation, of the New York Hospital, is as follows

Hippuran N N R	16 0 gm
Tragacanth U S P (Extra Select Scales)	1 5 gm
Glycerine U S P	19 1 cc
Merthiolate 1 1000 solution	10 0 cc
Distilled water	100 0 cc
q s ad	

Add 50 cc of water to the tragacanth to form a smooth paste. Add the glycerine and merthiolate. Dissolve the hippuran in the rest of the distilled water and add this solution to the paste with constant stirring. Strain through gauze if necessary.

*Umbrathor* a 25 per cent solution of thorium dioxide, is particularly useful for the cystographic diagnosis of bladder tumors. It has a tendency to cling to bladder mucosa that is in any way abnormal, so that if the medium is withdrawn and air introduced into the bladder, an impression of the abnormality is obtained. It also coats bladder stones, so that a definite shadow of the stone will be cast and its size and shape shown. It is therefore helpful in diagnosing non shadow casting calculi.

*Lipiodol*, though less popular than it formerly was is still favored by some urologists for urethrography. Flocks and Alcock's method of preparing the lipiodol medium is the one commonly used in American urological clinics.

### Technic

**Technic of Injection Cystography** A flat plate is first taken of the vesical area, with the patient in the dorsal position.

The bladder is emptied with a soft rubber catheter, then filled comfortably full with contrast solution, the catheter withdrawn, and exposures made in the antero posterior and oblique positions. About 150 cc of the opaque solution is normally required.

The bladder is again emptied by catheter, refilled immediately with air by injection with a 60 cc Asepto syringe, and another exposure made. The *contrast cystogram* thus obtained is useful in diagnosing neoplasms, tabetic bladder, and particularly, diverticula. Usually the air filled bladder will stand out in marked contrast to the pouches, which have not had time to empty themselves of the opaque medium. The contrast cystogram will also generally give valuable evidence as to the number and relative size of the pouches. Occasionally, however, a diverticulum will empty too soon for the contrast cystogram to expose it. The method

is, therefore, not infallible, and the findings should be carefully compared with those of cystoscopy

In cases of prostatic obstruction, the aerogram is taken before the cystogram

**Cystography, Using Umbrathor** A comparatively simple method of outlining the bladder, when search is being made for suspected vesical tumor has been suggested by Wesson and his co-workers, who make use of umbrathor a 25 per cent solution of thorium dioxide

The bladder content is emptied by catheter into a measuring glass, and the amount of withdrawn urine carefully noted. An equal amount of fluid, consisting of umbrathor and water, half and half, is then injected into the empty bladder. About 50 cc is usually required. At the end of 10 minutes, the fluid is withdrawn and air injected into the vesical cavity. The amount of air should be 30 cc less than the previously ascertained bladder capacity. The umbrathor is deposited upon the mucosal lining of the vesical cavity as a flocculent coating, and unless the x ray exposures are made promptly this coating may separate, thus ruining the cystogram. If successful, however, any existing tumor will be clearly outlined.

**Aerograms** The injection of air has been very successfully used for the roentgenological diagnosis of bladder tumors. This method can be used when a cystoscopic examination is impracticable.

Anterior and posterior roentgen ray exposures should be made before injecting the air. These will give information of the condition independent of inflation and the relation of any gas or air which may be present in the pelvic colon or rectum. Vesical calculus if present, is usually visible in these preliminary pictures.

After cleansing the urethral orifice as for ordinary catheterization, as large a urethral catheter as can be passed without discomfort to the patient is inserted. Residual urine must be removed from the bladder, compression usually being necessary to eliminate as nearly as possible all fluid from the viscus. Using a 60 cc Asepto syringe, air is then injected into the bladder until the patient complains of fulness. Care must be exercised not to overdistend the bladder, for it would be perfectly possible to rupture a diseased viscus, but if the injection is made slowly, and the patient's complaints promptly heeded, there should be no danger. Care must also be taken when introducing air into the bladder in the presence of hemorrhage, as a fatal air embolism might occur.

When the bladder is sufficiently distended, one or more plates should

be exposed posteriorly, after which the patient is turned on the abdomen and further films made anteriorly, directing the rays through the bladder obliquely from below upward, so as to avoid the pubic arch as much as possible

**Technic of Injection Urethrography** For injection urethrography we prefer hippuran as the contrast solution

The patient is placed in the dorsal position the urethral orifice cleansed a catheter inserted, the bladder emptied, and immediately refilled with air About 30 cc of opaque solution is then injected into the urethra with a urethral syringe Roentgenograms are taken while the injection is being made

**Visualization of Urethra and Bladder (Cysto-urethrography)** For obtaining cysto urethrograms we proceed as follows The patient is instructed to void He is then prepared in the routine manner With the patient in the dorsal position an x ray opaque urethral catheter is introduced and the residual urine, if any, withdrawn and estimated The catheter is left in position

The patient is now placed on his right side in the oblique position, with the right thigh flexed to about 45 degrees and the left thigh extended The bladder is filled with air the injection being stopped as soon as the patient declares he has a sensation of fullness

The urethral catheter is next removed the operator meanwhile holding the terminal portion of the urethra closed with his left hand A syringe, to which is attached about 2 inches of a No 16 French whistle tipped catheter, and which is charged with 30 cc of hippuran jelly, is taken up with the operator's right hand, and the catheter inserted into the urethra, which the left hand keeps closed about it as it enters The assistant protects the operator's left hand and arm by a lead plate as the operator slowly injects about 15 to 20 cc of contrast medium into the urethra When this amount has entered the urethra, a sense of resistance will usually be experienced by the operator, due to sphincteric contraction About 10 cc more is then slowly injected, and the technician instructed to expose the film, the injection being continued as the exposure is made For the second film, the injection is stopped while the film is being placed in position, but is continued during the exposure Thereafter the syringe is removed, the catheter reinserted the contrast medium entirely drained away the air removed and the bladder and urethra irrigated with boric acid solution or sterile water

The patient is now placed on the table in the dorsal position for antero

posterior exposures. A 3 per cent solution of sodium iodide is then injected into the bladder until the patient complains of a sense of fullness, and an x ray is taken.

In cases of vesical diverticula it is important to determine whether the diverticula are retentive. In these cases the urethral catheter is reinserted and the bladder emptied. The patient is again placed in the oblique position and an x ray taken.

The effectiveness of this combination air cystogram and opaque medium urethrogram in demonstrating conditions existing with prostatic abscess, penurethral abscess, median bar, contracture of the vesical neck, cord bladder, and all types of prostatic enlargement has been amply demonstrated.

The above method is a modification of Flocks' method of visualizing the posterior urethra, using lipiodol gum tragacanth mixture for the urethrogram.

**Excretory Urography for Examination of the Bladder and Urethra**  
The opaque medium may also be administered intravenously using diodrast, neo-iopax, skiodan, or hippuran, or subcutaneously, using diodrast, or perorally, using hippuran. The preparation of the patient is the same as for intravenous pyelography (p. 141).

### *Uses of Cystography and Urethrography*

As x raying an injected contrast solution provides the examiner with little more than the outline of the organs under investigation, it is in conditions producing alterations in the conformation that this method finds its greatest usefulness. Cystography, urethrography, and cystourethrography are important chiefly in the diagnosis of prostatic enlargement and vesical neck obstruction, diverticulum, tumors, stone, and traumatic injuries to the bladder and urethra—particularly if urethral obstruction, excessive hematuria, or excessive irritation makes the use of the cystoscope or urethroscope impossible or inadvisable. Used in conjunction with cystoscopy or urethroscopy, they greatly facilitate prompt and accurate diagnosis.

Because of the comparative ease with which the urethra in the female can be endoscoped, roentgenography of the female urethra, though a simple procedure, has received but scant attention. Urethrograms have, however, their definite uses, particularly in demonstrating stricture, diverticulum, suburethral abscess, and lesions of the lower urinary tract suffered during gestation and labor. The best information is gained when both oblique and antero-posterior views are taken.



**The Normal Bladder** Cystograms of normal bladders will show the viscus to vary in shape and size. The shadow of the male bladder may be *rounded or slightly ovoid, pyramidal or piriform*. In the female, the dome may be depressed by the uterus. The outline, however, is always smooth, and if any irregularity exists, it is indicative of a pathological condition.

**Prostatic Hypertrophy and Vesical Neck Obstruction** Both before and after operation the normal outlines and relations of the posterior urethra, the vesical neck, and the fundus of the bladder are distorted, and it is in their return to relatively normal shape and position that the surgeon can judge the success or failure of his efforts. In order to interpret his cysto urethrograms intelligently, the examiner must, of course, possess complete familiarity with the normal appearances.

Cysto urethrograms are particularly helpful in demonstrating the various types of vesical neck obstruction and in deciding which procedure to employ in getting rid of prostatic enlargement—whether suprapubic or perineal prostatectomy, or transurethral resection.

**Tumors of the Urethra and Bladder** Both injection and excretory urography, as well as aerograms, are of great usefulness in vesical neoplasms and the much rarer new growths of the urethra.

**Bladder and Urethral Calculi** "Bladder stones" formed about foreign bodies as nuclei are relatively common, but it is probable that the greater part of the calculi composed of urinary salts which are first manifested in the bladder, form higher up, and on reaching the bladder are detained and increased in size by an encrustation of urinary salts. Stones not infrequently form in vesical diverticula.

Urethral calculi are comparatively rare findings. Stones may form in urethral diverticula, and, rarely, a calculus formed in the upper urinary tract may be detained in the urethra after passing through the vesical outlet.

*The diagnosis of vesical and urethral calculus is usually made by plain x rays and by cystoscopy or urethroscopy, but when the passage of the instrument is impossible, cystography or urethrography becomes an important aid.*

**Vesical Diverticulum** Diverticulum of the bladder may be congenital, but more often is acquired and due to back pressure from obstruction at the bladder neck—a common occurrence in both benign and malignant prostatic enlargement.

Diverticula occur most often at those places in the vesical wall where it is weakest, namely, in the vicinity of the ureteral orifices and the inser-

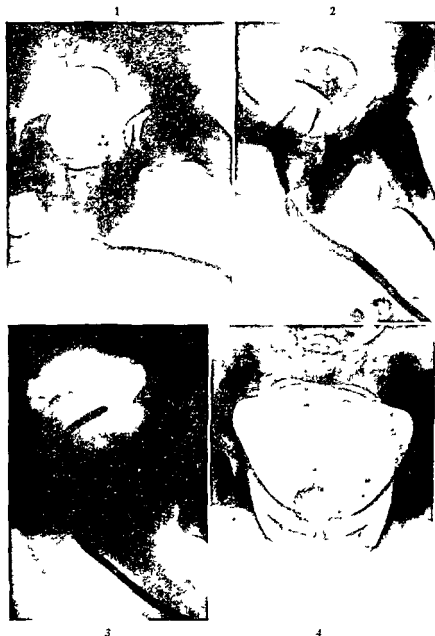


FIG 30 (1) Normal prostatic urethra Cysto-urethrogram (using hippuran jelly)  
 (2) Horse-collar type of intravesical prostatic hypertrophy (3) Showing tri lobar prostatic intrusion (4) Multiple prostatic calculi composed of calcium phosphate and calcium carbonate

tion of the urachus at the vertex. In the latter location there not infrequently exists a permanent congenital defect. A diverticulum at or near a ureteral orifice may result in serious derangement of the upper urinary tract by pressing upon the trigone or the lower part of the ureter, blocking the outflow from the kidney, and inducing hydronephrosis or stricture of the ureter, or even complete destruction of both the kidney and ureter of the affected side.

Vesical diverticula are much more frequent in men than in women.

Cystography is of great assistance in the study of vesical diverticulum. These studies should always be made stereoscopically in order to distinguish the position and exact extent of the pouch. Owing to the fact that many of these lesions are posterior, they may be obscured by the shadow of the opaque fluid within the bladder cavity, making it difficult to differentiate the diverticulum from the vesical cavity proper. It is our practice to take a cystogram of the distended bladder, withdraw the opaque fluid with a catheter, and take another roentgenogram immediately, the bladder being distended with air. This will often show the cellule or diverticulum still filled with opaque solution the bladder being empty.

**Urethral Diverticulum** The outlining of urethral diverticula, in both the male and the female is best done by injection urethrography, using lipiodol or one of the newer media.

Pouches along the course of the urethra are in rare instances of congenital origin. Usually they are caused by the lodging and increasing pressure of stones evacuated from the bladder or, in men who have led catheter lives, by instrumental injury. The existence of congenital valves or of acquired stricture may cause such dilatation as to result in the formation of permanent pouches above the constricted areas.

**Rupture of the Bladder** Rupture of the bladder, while by no means common, occurs often enough to make an available and accurate method of diagnosis of great importance. It is essential that the investigation be conducted in a manner calculated not to increase the injuries already suffered nor to subject the patient to greater shock than he has already undergone.

Rupture of the bladder may be either intraperitoneal or extraperitoneal, and almost always occurs when the cavity is full. A normal bladder containing little or no urine will seldom give way even under severe trauma. If hematuria is marked cystoscopy is usually contra-indicated, and even the passing of a catheter is hazardous.



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FIG 31 (1) Multiple stones in diverticulum of the bladder. Flat plate. (2) Large vesical calculus composed of triple phosphates. (3) Air cystogram using umbrothor, bringing into relief two negative stones in the bladder (uric acid). (4) Diverticulum of the bladder. Cystogram (lateral) with sodium iodide 10 per cent. (5) Retentive diverticulum of the bladder. Air cystogram (supine). (6) Carcinoma of the bladder. Cystogram (supine) sodium iodide 10 per cent.

In such a situation, cystography, with intravenous or peroral administration of the contrast medium, is a safe and satisfactory way of exploring the injured bladder, and its technic is so simple that it can be applied by any physician who has access to x ray or fluoroscope. Within a few

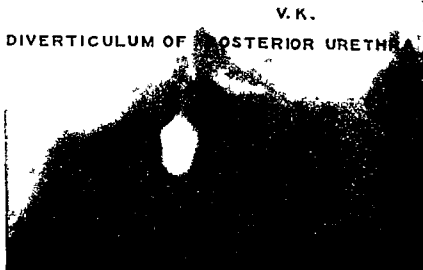


FIG. 32 Diverticulum of the posterior urethra male

minutes of the intravenous or peroral administration of a suitable contrast solution, such as hippuran, neo-iopax, or diodrast, a good outline of the bladder may be obtained. If a tear has occurred, of sufficient size to permit extravasation, the presence of the contrast medium outside the bladder outline will at once reveal its location.

If the intravenous or peroral method cannot be utilized, cystograms may sometimes be made by injecting a 3 per cent solution of sodium iodide in sufficient amount to cause a sensation of fulness. After one exposure has been made, the fluid is withdrawn and a second picture taken, after which air should be injected so that a contrast cystogram can be made. This is an excellent way of locating traumatic injuries, but has the great drawback of increasing the danger to the injured patient.

**Traumatic Injuries to the Male Urethra** In most accidents involving the urethra, the extent of the complicating injuries is so great that it is impossible to make a satisfactory exploration of the urethra itself. If the canal is completely severed, it will be impossible to pass a catheter, and in any event the wisdom of passing a catheter under such circumstances is questionable. The judgment of the attending physician may be severely taxed in trying to decide how much interference is justified, but the injection of a contrast medium from below is not likely to work harm and may be of great help in locating the injury and judging of its extent. Proper delineation of the urethral outline means, however, that the patient must have voluntary control, permitting evacuation by natural means, which is often impossible in a shocked and injured subject. In order to show the outline of the urethra, in profile, as Braasch has pointed out, the pelvis must be inclined to an angle of 45 degrees, the thigh of the lower extremity must be in extreme flexion, the upper thigh and leg extended and the x ray tube angled about 15 degrees toward the patient's feet. In many injuries such manipulation of the patient would be impossible. Therefore, the intravenous method is likely to be the easiest and most satisfactory.

**Urethral Stricture, Cystocele, and Other Lesions in the Female Demonstrable by Urethrography and Cystography** Urethral stricture is undoubtedly the unrecognized offender in many obscure cases of urinary tract disturbance in the female. Contrary to the general belief, an abnormal narrowing of the female urethra is a fairly common condition. In a total of 1,227 female patients with urinary symptoms, William E. Stevens found strictures in 458, or 37 per cent. These strictures may be either congenital or acquired, and are most frequently found at the external meatus. They are often responsible for pathology of the upper urinary tract and for a variety of subjective symptoms, including pain in different locations. Their early detection and correction are therefore of the greatest importance.

Urethrograms are not only useful in pointing out all types of stric

tures, both of scar tissue and retraction without scarring, but, as Crabtree and his co workers have demonstrated, they enable one to discern a dilatation of the posterior urethra similar to that observed in the male

Urethrography is of assistance in demonstrating the presence of some of the less common pathological conditions in the lower part of the female tract which cystoscopy may not reveal. Suburethral abscess, for example, will not always be discovered by cystoscopy if the opening into the sac is very small, but in the contrast urethrogram the location of the pus collection will be plainly evident. Inflammation and encysting of Skene's glands, caruncle, diverticulum and rarely, hypertrophy of the internal sphincter, are also detectable by x ray.

Though incontinence is properly regarded as due to an abnormal condition of the bladder, anatomically such vesical disturbances are commonly the result of urethral pathology. Cystocele, for example, is due to mechanical causes that exert traction upon the vesical sphincter, inducing leakage. On a urethrogram taken after the injection of an opaque medium, bladder prolapse will be plainly demonstrated and loss of the urethra's normal curves, by the exertion of traction from below, observable. Such straightening of the urethra means that its attachments have been loosened, although quite possibly the vesical sphincter itself may have escaped injury. After gestation and delivery, the normal course and shape of the urethra may be much distorted, and the effect of this upon the vesical sphincter may be such as to result in more or less continuous gaping with consequent inability to control urination.

The degree and importance of cystocele can be satisfactorily gauged by repeated cystograms taken in various states of the bladder—for example, (1) in the attempt to void normally, (2) while straining to void the residual urine habitually left in the cavity, (3) with the vesical musculature entirely relaxed, etc. These observations are particularly valuable when there is complete prolapse of the bladder floor.

The ability to introduce an opaque medium into the bladder by the excretory method has made it possible in recent years to clear up many obscurities in the diagnosis of lesions of the female bladder. Cystography must, of course, be correlated with the findings of cystoscopy, the value of each being enhanced by its association with the other.

Vesical and urethral conditions in the female are so closely associated that they should be studied simultaneously. When the patient is a woman, therefore, it will be found that the condition of the urethra and bladder can be much more satisfactorily determined if the urethrograms and cystograms are considered together.



## L SEMINAL VESICULOGRAPHY

Seminal vesiculography—that is roentgenographic visualization of the seminal vesicle, ampulla, vas deferens and ejaculatory duct following the injection of an opaque medium—has become an important means of diagnosis in many pathological conditions in this region. The contrast solution may be introduced (1) by catheterization of the ejaculatory ducts and injection or (2) by injection through a vasotomy incision.

Retrograde catheterization offers a conservative, painless, safe, and reliable method of injecting the contrast medium. Repetition may be done at will, without impairment of function or patency, which is not the case with vasotomy. Injection of the opaque material through the ejaculatory ducts was first suggested in 1920 by Young and Waters, who used a specially designed forked cannula, with which they were able to inject both ducts simultaneously.

For the successful performance of this procedure a suitable instrument, such as the Lowsley-Peterson universal urethroscope (p. 94), the McCarthy ejaculatory duct catheterizing instrument or the Delzell ejaculatory duct catheter, is required.

### *Indications for Seminal Vesiculography*

Vesiculograms, made with suitable contrast material, reflect the size, shape, and structure of the seminal vesicles as well as the topography of the ampullae and vasa deferentia. Seminal vesiculography is useful chiefly in (1) the diagnosis of the various types and grades of vesiculitis, (2) the control of the clinical treatment of vesiculitis, (3) determining the patency of the vesical tract in sterility in the male, (4) the detection of anomalies. It is of little value in the diagnosis of tuberculosis, and malignancy of the seminal tract is of such rare occurrence as to be of slight clinical importance.

Vesiculography is indicated (1) when the vesicles are suspected as foci of infection in arthritis and other chronic conditions, (2) in sterility and impotence, to determine the patency of the ejaculatory ducts or vasa deferentia, (3) in the presence of persistent backache of undetermined origin, (4) in persistent posterior urethritis with evidence of verumontanitis, (5) in seminal vesiculitis, to determine the type and degree, and whether stricture of the ejaculatory or seminal ducts, or of the vasa is present.

*Technic (with Lowsley, Peterson Universal Urethroscope)*

Thorough dilatation of the urethra and observation endoscopy are necessary preliminaries to retrograde vesiculography. This preparatory treatment has been described in the section on Seminal Vesiculitis (p 544). Vesiculography is undertaken when the posterior urethra is sufficiently clear to permit instrumentation.

Two no. 4—French x ray opaque, whistle tip catheters are usually used, but if there is difficulty in passing these into the ducts, x ray opaque catheters with gold tips are used.

The urethroscope is passed and inverted as one would pass and invert a concave cystoscope for observation of the trigone. After adjusting the cystoscope holder to the position of the instrument, its beak is closed and the holder locked. Light and water connections having been made, the holder is loosened and the instrument slowly retracted until the verumontanum is visualized. When it is in full view, the urethroscope is advanced slightly until the protruding upper edge of the sheath extends over the verumontanum like a canopy. The holder is locked and the light trickle of water necessary for observation of the posterior urethra shut off completely without any diminution of the field of vision. The ejaculatory-duct orifices are sought for by rotating the telescopic unit to the right or left. Upon localization of the desired orifice the telescope is retracted until the light bulb becomes visible and sufficient perspective is obtained. The corresponding catheter is now fed in and by raising or lowering through rotation of the telescopic unit the catheter's tip is engaged in the ejaculatory-duct orifice to be catheterized (Figs 7 to 10).

Regardless of the angle into which the catheter had to be brought to insert it into the ejaculatory duct orifice, its further passage must be in the direction of the vesical neck. With the catheter passed to a depth of from 3 to 5 cm, contrast solution is injected through a catheter fitting cannule on a 10 cc. syringe until the patient experiences discomfort or pain in the corresponding inguinal region (about 3 to 4 cc). We have found a 40 per cent solution of skiodan or diodrast the most satisfactory medium. It is advisable to catheterize and inject one side at a time because of the high degree of skill required for bilateral catheterization.

Roentgenograms are taken immediately after the injection has been made. While the injection can be made under observation light connections should be disconnected when the vesiculograms are taken.

In interpreting seminal vesiculograms, the ejaculatory and seminal ducts, vesicles, ampullae, and vasa deferentia should be considered. Complete diffusion of the injected contrast material is necessary for an uniformly outlined vesicular shadow. Where the vesicular contents are thick and mucoid, the diffusion cannot properly take place, and the resulting shadows will be indistinct. Freely flowing purulent contents permit good diffusion and furnish clear-cut vesiculograms. Small-sized catheters in wide ejaculatory ducts permit regurgitation of the dye before injection of the seminal tract has been completed.

For vesiculograms of a normal vesicle, a physiologically distended vesicle, and various pathological types of vesicles, the reader is referred to the chapter on the Seminal Vesicles (Figs 108 and 109).

### *After-Care*

Patients who have been subjected to retrograde vesiculography should be advised to procure elimination of the vesicular contents within 2 to 3 hours by means of intercourse (Peterson). Any slight burning sensation the patient may feel after vesiculography will usually be immediately relieved upon ejaculation, and epididymitis avoided.

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## CHAPTER VI

### ANESTHESIA IN UROLOGY

There is probably no branch of surgery in which the question of anesthesia assumes greater importance than in urology owing to the fact that the urological surgeon so frequently operates upon patients who are in the poor risk group. In addition to the usual hazards of surgical intervention many urological patients—particularly those undergoing prostatectomy—are in the later years of life when impaired kidneys, heart and vascular system make doubly important the selection and administration of the anesthetic. Whether it be the aged uremic prostatic patient with unstable equilibrium or the younger age group with renal deficiency these patients present a problem requiring special consideration.

With the passage of time general inhalation anesthesia as a complete anesthetic finds less and less employment by urologists. As a supplement to regional anesthesia however it occupies a definite place in genito-urinary surgery. The advancements that have been made in the field of regional and local anesthesia during the past two decades have been an important factor in urological progress and the number and variety of anesthetics now available make the selection of the right agent and method a major consideration in surgery of the genito-urinary tract.

*The present chapter makes no claim to completeness. Much of importance has been touched upon only superficially. The chief object has been to provide a guide by which those who are unfamiliar with the properties of the various types of anesthesia may be enabled better to evaluate the respective merits and suitability of the many anesthetic drugs and methods at the urologist's disposal. In any examination of the materials and methods employed in a practice which is in a constant process of change and improvement one must bear in mind that what is in high favor today may be discarded tomorrow. It has seemed expedient to describe certain new anesthetic agents which are finding favor with urologists at the moment but this does not mean that they are given a final endorsement. Mention has also been made of certain methods whose popularity is definitely on the wane this is not for the*

purpose of recommending them, but merely to indicate their place in the advancement of anesthetic practice

Even in this day of specialization, it is most desirable that every surgeon have practical knowledge of the various methods of administering anesthesia. Nothing could be more foolish than for one to decide that he can work best under a single form of anesthesia, and thereafter demand that none other shall be used for those upon whom he operates. Several factors enter into the proper selection of the anesthetic in a given case: (1) the type of operation to be done, (2) the age and general systemic condition of the patient, (3) the presence or absence of cardiac, hepatic, renal, or vascular complications, (4) the length of time anesthesia will be necessary. The requirements of no two patients are identical, and routine employment of a single method is bound to spell disaster sooner or later. The wise surgeon will study his patient, evaluate carefully the factors presented in the individual case, and select the form of anesthesia which is easiest and safest in the circumstances.

In our own practice, a majority of the operations are now carried out under regional anesthesia. We do not, however, advocate that regional anesthesia be employed in all cases, for every surgeon is called upon to care for patients whose temperament is such as to make it impossible to carry out even the most trivial intervention while they are conscious of what is going on, and there may be other reasons for preferring a general anesthetic.

#### A PREPARATION OF PATIENT PRELIMINARY MEDICATION

Before evaluating the various types of anesthesia suitable in urological operations, it is essential to emphasize the careful preparation of the patient. The exact general and urological status of the patient must be determined, and if this requires preoperative treatment, it should be carried out. The cardiovascular reserve of the patient must be accurately estimated, as this is more important than his actual age.

*The barbiturates and opiates afford efficient preliminary medication.* The barbiturates given at bedtime serve a double purpose in that they (1) secure the patient a night of restful sleep and (2) act as a definite antidote to the toxic effects of the agents used in regional anesthesia. Phenobarbital, 0.1 gram ( $1\frac{1}{2}$  grains) at bedtime and 0.2 gram (3 grains) 1 hour before operation, is satisfactory. Amytal, nembutal, and tribromethanol prevent hyperactivity of the sympathetic nervous system. Nembutal, in doses of 1 capsule, or 0.1 gram ( $1\frac{1}{2}$  grains), at bedtime, and

1 or 2 capsules 45 minutes to 1 hour before operation, with or without morphine, 0.01 to 0.015 gram ( $\frac{1}{8}$  to  $\frac{1}{4}$  grain) and atropine sulphate 0.0004 gram ( $\frac{1}{150}$  grain), has been found very effective.

## B GENERAL INHALATION ANESTHESIA

**Drawbacks to General Inhalation Anesthesia in Urology** There are numerous reasons for the declining popularity of general inhalation anesthetics among urologists, not the least being the initial fear and excitement which one can never be certain of avoiding no matter how skilfully the gas may be administered. The psychic element looms so important in any intervention upon the genito urinary tract that one should avoid, whenever possible anesthetics which even for the briefest period tend to excite rather than to subdue the emotions.

A high proportion of urological operations are done on arteriosclerotic, hypertensive, uremic, or diabetic patients, to whom general inhalation anesthesia is often very dangerous. Inhalation anesthesia is also contra indicated in patients who are suffering from active pulmonary tuberculosis. If one kidney has been removed or its function is known to be markedly impaired surgical intervention upon its mate should not be done under ether anesthesia because of the well known irritative effect of ether upon the renal tissue.

Another contraindication to the use of gas anesthesia in urology is the increasing employment of electrically connected instruments. When such devices are to be employed, the use of an explosive and inflammable gas is out of the question. Some of the newer gas mixtures, such as ethylene and cyclopropane, might be used satisfactorily in cases where the after effects of ether—particularly the retching and vomiting—make ether's employment undesirable but the dangers of fire and explosion are greater with these than with ether.

Despite these drawbacks, it is to be hoped that urology will yet find increased uses for the inhalation anesthetics. Although it may come the day is yet far distant when the introduction of drugs directly into the blood stream or spinal fluid can be carried out with impunity equal to that attending the administration of a gas which can be withdrawn the instant anything goes wrong. Increased skill in the use of intradural and intravenous agents may steadily lessen these dangers but cannot wholly abolish them.

**Inhalation Anesthesia as a Supplement to Regional Anesthesia** As a supplement to regional anesthesia, general inhalation anesthesia occu



pies a definite place in urological surgery. For this purpose, cyclopropane is the first choice because of the rapid, smooth absorption and induction, and the relaxation it affords without increase in oxygen want. It is contraindicated, however, when electric devices are being used. Nitrous oxide is indicated in the later group of cases, but has distinct disadvantages, such as the inadequate muscular relaxation afforded, the length of time required for induction (during which operation must be discontinued), the presence of a struggling patient, and the danger of anoxemia in a patient already in oxygen want. Ethylene gives more relaxation than nitrous oxide, but has all its other disadvantages, as well as being highly explosive. Open ether vapor by the drop method assures considerable oxygen and affords relaxation, but the length of time required for induction is a disadvantage, as well as the fact that one has a struggling patient.

**Ether** The methods of administering ether are too well known to require any description in a text book of this character.

It should be emphasized, however, that there are many apparently trivial devices that can be employed to increase the safety of ether and facilitate its administration. It is readily admitted that much of the success of regional methods depends on clever psychic work on the part of the attendants who not infrequently are specially trained for this task, yet, how often do we hear anything of the psychic surroundings of those about to take ether? The subjects of prostatic, bladder, or kidney surgery are often mentally as well as physically depleted and in need of all the moral support that can be given them. When ether is used, small, preliminary precautions not only serve to make the postoperative reaction less distressing, but help the patient's morale by assuring him that his comfort and welfare are considerations of paramount importance.

Anointing the lips and nostrils with sterile vaseline, and placing a drop or two of sterile castor oil into each eye, will save the patient much discomfort the following day. When the surgeon has finished his work, it should be the anesthetist's concern to wash out the patient's stomach with sodium bicarbonate solution and to administer oxygen until consciousness returns. The much dreaded sequelae of ether anesthesia can be largely obviated by the observance of such precautions.

The anesthetist must always be gentle, but he should at the same time be able to command considerable skill in the handling of his patient. This comes, of course, with practice, but more important still is the anesthetist's desire to avoid injury or even discomfort to the patient.

**Nitrous Oxide** Because nitrous oxide is not eliminated by the kidneys, it is often chosen by urologists when a general anesthetic is deemed desirable. Unlike ether, it has only a trifling effect upon the blood pressure, although it does cause a slight increase in arterial pressure during the period of secondary saturation, when the amount of oxygen is being gradually reduced. However, because it gives insufficient muscular relaxation, its use in urological surgery is somewhat limited.

*Preliminary Sedative Medication* A much discussed subject in relation to the use of nitrous oxide anesthesia in urology is the preliminary administration of morphine and its derivatives. It has long been accepted that the usual preoperative administration of morphine and atropine retards the secretion of urine, and for this reason those who have used nitrous oxide for nervous patients and children in cystoscopy have usually omitted preliminary sedative medication. As morphine is often very valuable in securing the necessary relaxation in many of the urological procedures carried out under nitrous oxide, this question is of considerable importance.

Experiments to determine how much the action of the kidneys is actually affected by the usual preoperative administration of morphine and atropine were carried out at the University of Pennsylvania and reported by Haines and Millikin in 1925. It was found that morphine and atropine, injected in the usual hypodermic doses before the administration of general anesthesia, do not unfavorably affect kidney function. Although ether, given without preliminary medication, was found to inhibit kidney function in dogs, when preliminary morphine and atropine were given, renal action was unimpaired. These findings were confirmed by clinical observation, and at the University of California and elsewhere as well, so that there would seem to be sufficient evidence to contravert the general belief that morphine and atropine should not be administered preliminary to the use of nitrous oxide in urological cases.

*Disadvantages of Nitrous Oxide* Paradoxically, the chief danger of nitrous oxide anesthesia is its ease of administration. Because anyone can administer it, such administration is often done carelessly without due regard to the purity of the gas and attention to the small details which may loom large if neglected. Although it is conceded that nitrous oxide-oxygen excites less chemical reaction in the general organism than most inhalation anesthetics, and causes less disturbance of the nervous system, it must be remembered that it is an asphyxiant as well, and improper administration is capable of producing fatal results.

Other disadvantages are the inadequate muscular relaxation it produces and the length of time required for induction

Nitrous-oxide oxygen, which has retained its popularity among urologists much better than ether, often fails to serve in a prolonged intervention unless supplemented by ether at the close. So many urological procedures are now done upon the elderly, in whom hardening of the arteries is present in some degree, that cyanosis must be guarded against with special care. Ether must therefore always be in readiness to combat this complication in patients under nitrous oxide oxygen.

*Technic of Administration* Physiologically, nitrous oxide acts by replacement of the oxygen normally in the body tissues. The term "anesthesia," as used in this chapter, refers to the tissues' loss of response to irritating stimuli. Tissue irritability is always in proportion to the amount of oxygen contained in the tissues. Irritability decreases in direct ratio to the decrease in the oxygen content—that is, the more oxygen displaced, the deeper the anesthesia.

The process of oxygen displacement should be a gradual one, slow enough to allow time for the blood to absorb the gas and convey it throughout the circulation. Admixture of 7 to 10 per cent of oxygen during the first moments will slow induction. This is followed by pure nitrous oxide until the anesthesia is as deep as is necessary for the particular procedure to be carried out. This takes from 40 to 50 seconds. Thereafter, enough oxygen should be administered to *maintain* anesthesia, usually from 7 to 10 per cent by volume. The experienced anesthetist, by watching the patient's color, can judge whether sufficient admixture of oxygen is being given. The face should remain normally pink, the least bluish tint meaning that the blood is being deprived of oxygen.

The patient should breathe naturally. He should never be forced to breathe deeply and hard, for this causes over ventilation of the lungs and takes away too much carbon dioxide. The tendency of athletes and nervous individuals to begin by breathing very hard should be discouraged by the anesthetist placing his hand upon the patient's chest and bearing down, sometimes with considerable force.

When the patient is a child, it should be borne in mind that the younger the patient the more rapid the response, therefore, more oxygen must be used when prolonged anesthesia is necessary.

Respiratory and circulatory stimulants, such as adrenalin, caffeine,

metrazol, and strychnine sulphate, should always be at hand in case prompt resuscitation is necessary

**Ethylene-oxygen** Ethylene gas has been employed less extensively in urology than other inhalation anesthetics because of its unpleasant odor and the great danger of explosion, which makes its use dangerous when high frequency current or other electrical equipment is to be employed, or when roentgenographic examination may have to be made during operation

Ethylene also acts upon the circulation as a vasodilator, which tends to cause undesirable oozing of the operative wound. Other things being equal this is not a serious drawback, but must be remembered by those who elect to make use of this gas in their surgical work.

As the induction of ethylene-oxygen is rapid and pleasant—apart from its evil smell—many patients will prefer it. For operations of medium length, it gives moderate relaxation without cyanosis, and the recovery from it is so rapid and evil after-effects so slight that for relatively minor procedures it offers many advantages. It may be said to combine the relaxation afforded by ether anesthesia with the rapid recovery of nitrous oxide. This relaxation is obtained without the cyanosis, elevation of blood pressure, sweating and respiratory disturbance so frequently associated with ether.

**Cyclopropane** A fairly recent addition to the list of agents for inhalation anesthesia is cyclopropane. Although the gas itself was discovered by Freund in 1882, it was not considered available for surgical anesthesia until 1929, when Lucas and Henderson, in Canada, employed it experimentally in animals, their work being later repeated and amplified by scientists in the United States. Thus cyclopropane is a distinctly American product.

Marketed and handled much as other gases for general inhalation anesthesia, it has so far exhibited several distinct advantages over its predecessors, both as a complete anesthetic and as a supplement to regional or local anesthesia. It can be administered in any of the usual ways—by oral insufflation or by the more elaborate methods. It seems to be the consensus of opinion that a completely closed method, with carbon dioxide absorption, is the most generally satisfactory. The carbon-dioxide absorption technic described by Waters reduces or prevents shock produced by loss of body temperature. Wineland has shown that the body temperature can be raised from 1° to 3° with this method.

Cyclopropane is very potent, complete unconsciousness being brought

about in from 20 seconds to 3 minutes. When correct administrative technic is employed, there is no choking, strangling, or resistance on the part of the patient, and there are rarely any of the unpleasant after effects regularly experienced with ether and most other gases.

Because of the rapid absorption and induction, and the fact that it affords adequate relaxation without increase in oxygen want, cyclopropane is the first choice among inhalation anesthetics. Its use is contraindicated, however, when electric devices are to be employed.

Cyclopropane has recently been used in conjunction with rectal anesthesia by means of avertin, and this combination seems to provide an easily taken and effective means of producing analgesia of any depth desired.

### C RECTAL ANESTHESIA (WITH AVERTIN)

The employment of rectal anesthesia began during World War I with the introduction by Gwathmey of his colonic ether-oil method. In 1926, almost a decade after Gwathmey's earlier work, the drug tribromomethylalcohol was synthesized and popularized under the name of avertin. In its now available form, avertin is a white crystalline powder which is easily dissolved in water heated to about 40°F. Higher temperatures break down its molecule, which is very labile. It is made up with distilled water into 2½ and 3 per cent solutions.

*Advantages and Disadvantages.* It is as a so-called basal anesthetic that avertin has shown itself most useful in urological surgery. The avertin is used as a basis to induce anesthesia, which is maintained as long as is needful by supplementary gas or ether. Too deep avertin hypnosis has proved dangerous, and it is not wise to attempt to depend on it when prolonged intervention is contemplated. The combination of induction by avertin and maintenance by nitrous oxide oxygen has given complete satisfaction to many surgeons. Two definite advantages of this method, in suitable patients, are (1) it can be used when electric devices are employed, (2) the oxygen content of the mixture may be considerably increased without decreasing the surgical relaxation, thus avoiding anoxemia and shock. Avertin combined with cyclopropane has proved satisfactory when electrical instruments are not to be used.

In urological procedures upon children, avertin has worked admirably, as sleep may be induced while the child lies in his bed, and he is unaware that the enema he has received differs from that given him the previous night.

The only distinct contraindications to the use of avertin are (1) liver disease, for it is the liver which must detoxicate the drug, and (2) ulceration of the rectum, which would prevent or impair absorption of the drug. It would also seem to us unwise to employ avertin in the presence of severe renal impairment, although many writers claim that even advanced nephritis is not a contraindication. However, with other satisfactory methods of anesthetizing such patients available, the use of avertin would certainly seem ill advised.

*Technic of Administration* The usual dosage is from 60 to 80 mgm per kilogram of body weight. There can be no exact rule for dosage because experience has shown that, in general, children and young adults require more, and the fat, the weak, and the very aged require less. Any patient whose elimination is seriously impaired must be given much less than the average dosage.

A cleansing enema is given the night before the operation. An hour or less before the operation, sedative medication is administered (Preliminary Medication, p 191). Fifteen minutes before the operation, the entire dosage of freshly prepared avertin is injected into the rectum through a short rectal tube. The drug is very rapidly absorbed by the intestinal mucosa, but should any signs of idiosyncrasy appear it will be possible to flush the rectum immediately with sterile water, washing out most of the solution and diluting the remainder so that its action is practically inhibited. This possibility of withdrawing the anesthetic in case of accident has a strong appeal to some surgeons, as well as to patients. In practice, it has hardly ever been found necessary, as proper preparation of both patient and solution will obviate all dangers.

The deep sleep into which the patient immediately falls usually lasts for two hours or more. There is no preliminary excitement and no unpleasant reaction on awakening. Respiration becomes quicker and more shallow, and there is a fall in blood pressure although the pulse usually remains near normal. There are no evidences of shock even when the fall in arterial pressure is considerable.

When slumber becomes profound, the auxiliary gas or ether is put into service if the operation is likely to be long or difficult. For relatively minor procedures the rectal anesthetic alone is often adequate.

#### D REGIONAL ANESTHESIA

*Advantages and Disadvantages of Regional Anesthesia* Some form of regional anesthesia is the method of choice in the vast majority of

urological operations The chief advantages of the regional methods for urological cases are (1) its greater safety (there is little disturbance of blood pressure, with, consequently, less bleeding, less shock, and lower mortality than with inhalation anesthesia), (2) the complete muscular relaxation afforded, (3) the freedom from hemorrhage, making possible a drier field, (4) the fact that patients may take fluids before, during, and immediately after operation, (5) the absence of postoperative nausea and vomiting, (6) the fact that they can be safely used when the electro cautery or high frequency current is employed

Disadvantages of regional anesthesia are (1) the inability to eliminate the agent in an emergency, (2) the fact that the patient is conscious

A distinct advantage that regional anesthesia, with a conscious patient, offers to urological surgery is the early detection of pain and shock following rupture of the bladder during transurethral resection (R. Andre, 1939)

Regional anesthesia is especially satisfactory in patients with renal and cardiac impairment in the presence of vascular lesions and high blood pressure, also in diabetic patients and those with active pulmonary tuberculosis Its routine employment is, however, as unwarranted as that of any other single procedure

**Spinal Anesthesia** Spinal anesthesia has become increasingly popular in urological surgery during the past decade Briefly, it may be defined as anesthesia induced by the introduction of drugs into the sub arachnoid space This requires a spinal puncture, the drug being mixed with the fluid withdrawn, and the mixture then reinjected into the spinal canal through the same puncture

*Early Use in Urology* Although spinal anesthesia is now employed for operations on many other parts of the body, it was for the purpose of anesthetizing the organs of the genito-urinary tract that analgesic drugs were first injected into the spinal canal In 1885, Corning published an account of injecting an anesthetic "between the spinous processes of the lower dorsal vertebrae" This produced (as the experimenter had hoped) complete loss of sensation in the legs and external genitalia, and permitted him to pass a sound through the urethra without the patient being aware of the instrument's entrance The report concludes with the reflection "Whether the method will ever find application as a substitute for etherization in genito urinary surgery further experience alone can show" As cocaine was then the only available local anesthetic, Corning's method proved too dangerous for regular use

In 1899, Tuffier reported 80 cases wherein he had injected cocaine between the third and fourth lumbar spaces. At that time he had not personally tried, but nevertheless strongly recommended, injection of intravertebral spaces higher up, in order to induce anesthesia in the renal region for operation upon the kidneys. But the method was even then so far from being safe, despite the greatest care and skill, that it did not become popular.

*Introduction of Less Toxic Agents* In 1891 Giesel produced a modification of cocaine, which he called tropacocaine. This substance attained considerable popularity among German urologists, and is still employed in certain clinics. In 1903, Fournier isolated another derivative, which was named stovaine. This had a considerable vogue, particularly in France, but was largely displaced when Einhorn, the following year, produced novocaine, which was employed with gratifying success in his subarachnoid method by Braun, one of the pioneers in local and regional anesthesia. Under the name procaine this less toxic cocaine derivative found some acceptance in America at the time of its introduction and has gained steadily in favor ever since. Other preparations put forward in this country, after having been used in European clinics, are totocaine and percaïne, the latter—known here as nupercaine—having many advocates. Butyn, isocaine, and pontocaine are still other anesthetics which have found favor with American urologists.

Improved drugs combined with greater skill in their administration, have so increased the safety of spinal anesthesia that it is now regarded by urologists as the best method for use in surgery of the urogenital tract.

*Indications and Contraindications* In general spinal anesthesia is best suited to patients in good systemic condition, presenting an operative field well below the diaphragm. For patients with an excess of sugar in the urine, or the frankly diabetic, it is distinctly advantageous since it does not cause acidosis.

Unless there is very marked hypertension, high blood pressure does not, as a rule, contraindicate the use of spinal anesthesia. Low pressure, on the other hand, is a strong contraindication, and this form of anesthesia should never be used for patients whose systolic pressure is under 100 mm Hg. Other contraindications are coronary disease, cerebrospinal lues, anemia (hemoglobin less than 50 per cent), and severe shock. Patients with these disabilities cannot accommodate themselves to the radical changes in blood volume shifts of the cardiovascular system, nor can they tolerate the effects of anoxemia. With increased



experience, however, contraindications for spinal anesthesia have greatly decreased

*Technic of Administration* The drug most commonly used for spinal anesthesia is novocaine hydrochloride. Nupercaine has also proved satisfactory. At the Brady Foundation we use novocaine crystals as a rule. We also use pontocaine, and occasionally nupercaine. The general rules for handling patients anesthetized by the spinal route are the same, irrespective of the agent used.

The dosage depends on the weight of the patient, the type of operation, and the length of time anesthesia is desired. The position of the patient, the dilution of the drug, and the rate of injection all influence the level and duration of the anesthesia.

Preliminary medication is desirable (Preliminary Medication, p. 191).

Spinal anesthesia is often administered with the patient in a sitting position. The anesthetic is also injected with the patient lying on his side, with knees flexed, head bent forward, and back curved outward. This separates the spinous processes and permits easy and painless puncture.

The skin at the point of puncture is sterilized with iodine, 3.5 per cent, sponged off with alcohol, 70 per cent.

For intervention upon the kidney or the upper third of the ureter, the injection is usually made in the first lumbar space; for bladder, prostatic, or scrotal operations, the injection is usually made in the second lumbar space, and for operations on the penis, urethra, or perineum, in the third lumbar space.

A 1 per cent solution of novocaine (procaine) is injected subcutaneously before the spinal puncture is made. In our practice, ephedrin hydrochloride, 5 per cent (0.05 gm.), is administered in this preanesthetic injection.

When the spinal needle (9 cm., 22 gauge) is in place, the stylet is withdrawn. The spinal fluid will then drip from the needle and is caught in the ampoule containing the novocaine crystals, thereby dissolving the crystals and making a solution for injection. The solution is withdrawn from the ampoule by a 22 gauge 5 cm. needle. This needle is then removed from the syringe, the syringe attached to the spinal needle, and the solution reinjected through the same puncture.

Following the injection of the drug the patient is placed in the dorsal position, with sufficient supports beneath the head and shoulders to keep them well elevated.

The action of a drug thus introduced is very rapid, and the operation can usually start as soon as the patient can be transferred to the operating table and prepared

*Failure to Obtain Complete Anesthesia* Partial or complete failures in spinal anesthesia may result from a number of causes. The drug used may have lost its potency through repeated sterilization or other causes. Such difficulties are now largely obviated by the employment of previously prepared dosage in sealed ampoules, or by the use of crystals if novocaine is the drug selected. The needle may not have reentered the spinal canal when the mixture of spinal fluid and anesthetic was injected. If the injection has been extradural, it will obviously be ineffective. The dosage may have been insufficient, or the intravertebral space selected may not have been the one best suited to the particular operation. Sometimes no cause can be found for failure or only partial success. Seldom does careful technic fail to produce some degree of anesthesia, but in a minority of cases supplementary inhalation anesthesia with gas-oxygen or ether is necessary to complete the operation (*Inhalation Anesthesia as a Supplement to Regional Anesthesia* p 192)

*Preventing Undesirable Sequelae of Spinal Anesthesia* Most of the untoward results of spinal anesthesia that have been reported can be avoided if proper precautions are observed. The severe and even fatal reactions noted by earlier observers have now been banished from the urological clinic. Convulsions, paralysis, and coma are no longer seen, due to the introduction of less toxic drugs and the standardization of the technic of administration. This does not mean that all danger has been eliminated. There still remain the hazards due to carelessness, haste, the use of improper materials, and poor selection of patients. But with suitable equipment, there is no reason why an experienced anesthetist, well grounded in anatomy, physiology, and the pharmacology of the drug he proposes to use, should not invariably have satisfactory results on properly selected patients.

The collapse and respiratory failure, which so terrified earlier workers, are caused by a fall in the blood pressure. Other possible sequelae include neuritis and slight temporary paralysis, due to disturbance of motor or sensory nerve centers, abdominal distention and gastric symptoms, such as nausea and vomiting, headache, which is usually extremely severe and prostrating, and meningeal symptoms other than headache, such as backache, extreme nervousness, and even hallucinations.

A fall in blood pressure may be due to the toxic action of the injected

drug upon the nerve fibers or the centers from which they derive, or it may be the result of shock induced by the spinal puncture—something that may happen to susceptible persons no matter how carefully the puncture is made. When this occurs, it usually takes place during the first 15 minutes after the spinal tap has been made—occasionally later, if the patient is moved upon the table or otherwise unduly disturbed. It takes about 15 minutes for the effect of the drug upon the nerve centers to reach its maximum, and during this period the functional powers of the entire body are being depressed. Thereafter, the patient should rally and gradually overcome this depressing effect, so that at the end of the operation the general condition is far better than at the outset—precisely the reverse of operations done under general anesthesia.

If *anesthetic shock* occurs—that is, the blood pressure falls abruptly during the first minutes of anesthesia—this must be controlled with oxygen inhalations, the use of the Trendelenburg position, and injections of coramine (1.5 to 3.0 cc intramuscularly or intravenously) or adrenalin, 1:1,000 (0.5 to 1.0 cc). Ephedrin has a more lasting effect than epinephrin, but causes increased heart rate and is not safe to repeat. Johnson *et al*, of Northwestern University, advocate synephrin hydrochloride because of its more lasting effect and the fact that it may be repeated at frequent short intervals without disturbance of heart rhythm.

Many anesthetists inject adrenalin routinely before the anesthetizing drug is administered. It is our practice to administer ephedrin hydrochloride, 5 per cent, in the preanesthetic injection (novocaine, 1 per cent), reserving the use of adrenalin until evidence of a rapid decrease in blood pressure is observable. Where the injection method (into the deep muscles of the gluteal region) does not have the desired counteracting effect, adrenalin may be employed in the form of an infusion. This solution should always be prepared beforehand and kept in readiness whenever spinal anesthesia is to be administered. The usual proportion is 1 minim of 1:1,000 adrenalin to each 100 cc of normal saline. If properly used, this should raise the blood pressure sufficiently to prevent collapse and maintain it there until the vital forces react so as to restore normal body function. It must always be remembered that adrenalin is a powerful heart stimulant and vasomotor constrictor, and should be employed only in high dilution, allowed to run in very slowly, and the infusion stopped the instant the desired effect has been obtained.

The best way to deal with these complications of low blood pressure is to handle the patient from the outset in such a manner as to avoid them.

altogether To that end a definite routine should be followed at all times giving attention to the following points

- 1 Show the patient, before operation, exactly how he should breathe Deep, quiet, regular breathing is essential

- 2 Have the blood pressure taken every 5 minutes, particularly during the first part of the operation

- 3 Give adequate preoperative medication

- 4 Give a preliminary administration of ephedrin, as outlined above

- 5 Be sure that the amount of novocaine, pontocaine, nupercaine, or other cocaine derivative used is very carefully calculated in relation both to the patient's body weight and the length of time the anesthetic effects are desired The time required for operation cannot always be exactly gauged beforehand, but should be estimated as nearly as possible

- 6 As soon as the anesthetic drug has been injected, place the patient in the dorsal position, with sufficient supports beneath the head and shoulders to keep them well elevated Moist gauze or towels should be placed upon the patient's face and cracked ice kept at hand, so that a few fragments may be placed in his mouth should he complain of thirst

- 7 Administer oxygen throughout, except when the patient complains of nausea or other abdominal symptoms are in evidence Should these occur, the oxygen administration should be stopped immediately and the patient instructed to take 10 or 12 deep breaths through the mouth This will usually clear up the nausea and permit the administration of oxygen to be continued If the patient still complains of nausea, the head should be lowered and if distress is still evident the Trendelenburg position should be assumed

Generally speaking, when the blood pressure reading reaches a dangerously low level all operative procedures should be stopped and adrenalin infusion started Should the pulse grow fainter in spite of this administer artificial respiration with carbon dioxide and oxygen These measures are seldom required if the foregoing precautionary measures are faithfully carried out previous to and during the operation

*Shock due to adrenergic to novocaine is usually quickly controlled by artificial respiration with carbon dioxide and oxygen and the intravenous administration of ephedrin*

*Respiratory paralysis during a urological procedure under spinal anesthesia should not occur if proper precautions have been observed In "high" anesthetics—that is, operations above the diaphragm—the danger of this complication is greater The administration of oxygen*

and carbon dioxide is the procedure of choice for the relief of asphyxia and low blood pressure, where normal pulmonary ventilation is diminished due to paralysis of the intercostal muscles and diaphragm.

*Cerebral anemia* may be avoided by keeping the patient flat in bed for a full day after the puncture has been made.

*Meningitis and nervous disorders* are usually the result of poor technique and are far easier to prevent than to cure after they have occurred. Rigid attention to asepsis in making the puncture and in caring for the puncture site afterward so that there is no leakage of spinal fluid, usually all that is necessary to avoid nerve and meningeal disturbance. Intravenous infusions often help to relieve the intense headache which accompanies these manifestations.

Other aids when headache is severe after spinal anesthesia, are an ice cap to the head or cautious medication with atropine or even morphine.

**Continuous (Fractional) Spinal Anesthesia** In 1940 Lemmon, Philadelphia, introduced special equipment by means of which fractional doses of an anesthetic solution may be injected as necessary to maintain a continuous state of spinal anesthesia. The following year he reported a series of 500 cases in which this method was used. Numerous other reports have appeared in medical literature attesting the greater safety and controllability of the continuous method over older methods in lengthy operations (over 1½ hours) as well as in short procedures in poor risk cases. The continuous method eliminates one of the chief disadvantages of spinal anesthesia, namely, that of the drug's action wearing off before the operation is completed.

**Equipment** The necessary equipment consists of a specially designed rubber covered mattress and a very flexible German silver lumbar needle (18 or 19 gauge) connected to a 10 cc or 20 cc syringe with Luer Lok tip by means of a 30 inch length of small bore, rubber tubing which has a Luer Lok stop cock connection at one end for the syringe, and a Luer Lok connection at the other end for the needle. The mattress is 6 feet long, 18 inches wide, and 5 inches thick, and has a cut out section 7 inches long that comes under the lumbar spine when the patient is supine. The lower section may be detached for perineal operation. This section is also constructed so as to allow the feet to be dropped when a deep Trendelenburg position is desired.

**Drugs Used** All of the established agents for spinal anesthesia—procaine, metycaine, pontocaine, and nupercaine—have been used to produce continuous spinal anesthesia, but procaine hydrochloride (novi-

caine) appears to be the least toxic and is at present the most generally favored. In our practice we use procaine hydrochloride crystals dissolved in spinal fluid to make a solution which contains 50 mgm procaine to the cubic centimeter. The procaine comes in 200 mgm ampoules.

*Technic* The patient is placed in the left lateral decubitus position so that his back is toward the side of the mattress with the cut out section.

The site selected for spinal puncture depends on the site of the proposed operation (see Spinal Anesthesia Technic, p 201).

The skin at the point of the spinal puncture is sterilized with iodine 3.5 per cent, sponged off with alcohol, 70 per cent. A 1 per cent solution of procaine is injected subcutaneously. We routinely give ephedrin hydrochloride, 5 per cent (0.05 gm) in this preanesthetic injection.

The following description of the technic is taken, for the most part, from that of Lemmon. A Sise introducer is used to puncture the skin, and on withdrawal leaves a track for the malleable needle to traverse. When the spinal fluid escapes, a 10 cc Luer Lok syringe is connected and enough fluid withdrawn to make up the calculated dose (usually 300 mgm of procaine dissolved in 6 cc of spinal fluid). The syringe is disconnected and the needle plugged to prevent leakage of spinal fluid. The syringe containing the stop cock is attached to one end of the 30 inch length of rubber tubing; the stop-cock is opened, and 2 cc of the mixture is forced into the tubing, thus displacing the air and completely filling the tubing. The stop cock is then closed. The Luer Lok connection at the other end of the tubing is connected to the needle which was left in the spine. The stop-cock is opened and an initial injection of 2.5 to 3 cc of the mixture (100 to 125 mgm of procaine) is made into the subarachnoid space, and the stop-cock is closed.

With the needle left in position, the patient is carefully turned on his back so that the needle is in the center of the gap in the mattress. It must not touch the table or the mattress at any time. The patient should be maintained in a 5-degree Trendelenburg position during the induction period. If the desired level of anesthesia is not obtained in 10 minutes an additional injection (usually of 1 cc) is made. The height of the anesthesia can be controlled by the position of the patient, the volumetric dilution of the agent ('barbotage'), the rate of injection, and the total dosage.

Once anesthesia has been established, it is readily prolonged by small fractional doses (usually 25 to 50 mgm) of procaine as required.

*Segmental Peridural Anesthesia* The variety of spinal anesthesia known as the segmental peridural method originated in Italy. Although

quite widely used in European clinics, it has as yet found little popularity in the United States

*Technic of Administration* It is preferable to have the patient lying upon his side. The side on which the greatest depth of anesthesia is desired should be the one chosen.

The interspace selected for injection varies with the location of the operative area. For renal work, the first or second lumbar, or the twelfth dorsal, space serves best. For operation on the bladder or prostate, the third or fourth lumbar space will give best results.

Novocaine and nupercaine are the drugs most commonly employed, the average adult dose being 40 to 50 cc. of a 1 per cent novocaine solution, or saline nupercaine, 1,000.

Considerable skill is required to pierce the external tissue without penetrating the dura itself. The needle is introduced directly into the midline, and, although at first encountering considerable opposition, will give evidence of having entered the peridural space by the sudden cessation of resistance. The syringe should now be detached and the appearance of spinal fluid watched for, which would indicate that the dura has been traumatized. If either blood or spinal fluid appears, the needle must be withdrawn and a second attempt made at another spot.

If it is found that the point of the needle is in the peridural space, the first injection, of from 10 to 15 cc. of the anesthetic solution, may be made. The precautions regularly followed in spinal anesthesia must be strictly observed. A wait of 5 minutes should be made after the initial injection, to allow for the appearance of any possible evidences of toxic reaction, such as pallor, weakness and slowing of the pulse, or paralysis. If nothing untoward takes place, the injection of the anesthetic is continued and a period of 15 to 20 minutes permitted to elapse for the establishment of surgical anesthesia—that is, complete loss of sensation in the operative area.

*Advantages and Disadvantages* This method of inducing regional anesthesia has several advantages over the older methods, chief of which is the possibility of limiting anesthesia to the region of the proposed operation without danger of the effect spreading beyond these points. Also, there is regularly less fall in systolic pressure than is seen in the usual spinal methods. The liver, heart, respiratory and vascular systems and the digestive tract remain unaffected, and shock and collapse have been rare. But, as the anesthesia produced is not very profound, the method is unsuited to children and the excitable adult, and is not

adapted to operative procedures in which complete relaxation and deep anesthesia are essential. The length of time required for the anesthetic to take effect may also be a serious drawback in some cases.

**Paravertebral Anesthesia** Paravertebral anesthesia is accomplished by injecting with a local anesthetic the posterior roots of the spinal nerves at or near their point of emergence from the vertebral column, thereby temporarily interrupting the sensory impulses from the tissues supplied by these nerves.

The first reported instance of the use of paravertebral anesthesia in urological surgery appears to have been the nephrotomy performed by Lawen at Leipzig in 1911. The method received its greatest impetus, from a urological standpoint, at the large clinic of Professor Illyes in Budapest. Many modifications have been devised, by Hartel, Finsterer, Kocher, Labat, Torek, Lowry, Farr, Lowsley, and Pugh, Henline, and others. In 1924, Lowsley and Pugh presented a large series of cases in which this form of anesthesia had been employed with gratifying success. In recent years its popularity has suffered somewhat in competition with the many improvements in other forms of regional anesthesia.

**Authors' Technic of Administration (for Renal Surgery)** The patient is seated on the edge of the operating table, with the head bowed and the body bent slightly forward, the feet resting upon a support, or he may lie on the side opposite the one to be injected, with knees flexed, head bent forward, and the back curved outward, thus widening the intercostal spaces.

In paravertebral anesthesia as applied to renal operations, nerve blocking need be done on one side only, as most procedures are unilateral. Success depends upon blocking the eighth, ninth, tenth, eleventh, and twelfth dorsal nerves, all of which send off branches which eventually reach the lateral, anterior, and posterior parts of the abdominal parietes, supplying one or all of its cutaneous and muscular planes.

With the patient in position a long wheal is made by the injection of a 1 per cent solution of novocaine (procaine). The line of infiltration extends from a point just below the twelfth costovertebral angle, and 2 cm. from the midline, to the level of the eighth rib. All subsequent injections are made from this original wheal, and the patient should have it explained to him that this will cause him some slight pricking sensations, but thereafter the administration will be painless.

Injection is begun by inserting the needle 2 cm. from the midline opposite the spine of the seventh dorsal vertebra. It is pushed in until it strikes the angle formed by the lamella of that side and the transverse



process, then carried over the edge of the bone, the point deflected inward and again pushed downward to a depth of about 1 cm. The needle point should now be in the area occupied by the merging nerve roots. After applying suction, to be sure a blood vessel has not been invaded, 2 or 3 cc. of 1 per cent novocaine solution is injected at this point. The same procedure is carried out from entrance points over the ninth, tenth, eleventh, and twelfth dorsal vertebrae. The angle formed by the twelfth rib is well filled both above and below.

The patient is now laid on the sound side, and the entire loin, skin, subcutaneous fat, and muscular tissues infiltrated with an 0.5 per cent solution of novocaine, these injections also being made through the original wheal. By injecting both superficially and into the deep planes, all the nerves of the abdominal wall will be rendered insensitive to any incision in their vicinity.

In all, no more than 150 cc. of the 1 per cent solution is administered to a man of average weight. One gram per 100 pounds of body weight should invariably be the maximum amount employed.

Before beginning the initial incision, all anesthetized areas should be tested, the field screened from the patient's view, and his attention distracted as much as possible by the specially trained attendant. Insensibility will be established in the injected area by the time the patient is arranged on the operating table.

The incision should be made gently and cautiously, all tearing, roughness and heavy retraction being avoided. Careful, sharp dissection will not give the patient any pain, but any rough handling or traction is likely to do so. The initial incision should be made amply long, as more room is necessary when these precautions must be observed. If manipulation or clamping of the pedicle is felt by the patient, a little novocaine should be injected into the tissues of the pedicle before proceeding further. Infiltration of the tissues before cutting may also be necessary when adhesions are unusually tough or numerous—for example in renal tuberculosis, or a few whiffs of gas or ether may be required to supplement the paravertebral injections during the most painful part of the procedure or if the patient is unusually nervous. In the majority of cases this will not be necessary, and the patient should leave the table comfortable and without any evidence of shock. There is no postoperative nausea, and the effects of the anesthetic usually persist in some degree for 7 or 8 hours, thus giving the patient time to regain his normal blood pressure while still more or less insensitive to pain.

**Sacral and Parasacral Anesthesia** Injections into the caudal end of

the spinal cord were first successfully carried out by F. Cathelin and Durant in 1902, when they introduced various substances in the treatment of grave neuralgias, sexual neuroses, and incontinence of urine. The method was first applied to urological surgery of this region by A. Lawen in 1910.

Caudal and parasacral anesthesia is very useful in operations upon the external genitalia, perineum, prostate, bladder, and urethra, especially in old patients and those who are poor risks. With the proper type of patient, it is safe, devoid of complications, and effective, if the correct amount of anesthetic and technic is used and the operation not started too early. The effects may be augmented by either local infiltration or intravenous anesthesia using pentothal sodium. Another advantage is that it can be employed when the electrocautery or high frequency current is used.

Disadvantages are (1) the time required for injection and anesthesia, (2) the occasional incomplete or unsatisfactory anesthesia obtained.

*Preliminary Medication.* The patient is given sedative medication the night before and, again, 1 hour before the operation (*Preliminary Medications*, p. 191).

*Technic of Administration.* The patient is placed on the table, resting on his abdomen or upon the knees and elbows.

The skin at the point where the needle is to be inserted is sterilized with iodine, 3.5 per cent, sponged off with alcohol, 70 per cent. It is then infiltrated with novocaine, 1 per cent.

The operator palpates the coccyx, and, sliding his finger above this bone, reaches the lower part of the sacrum, where he is usually able to palpate the sacral hiatus without difficulty. The sacral horns approximate the lateral borders of an imaginary triangle of which the hiatus is the apex.

A 20-gauge needle 9 cm. long is inserted through the anesthetized skin and into the sacral canal by puncturing the ligament which covers its lower end. After penetrating the ligament, the needle is easily pushed in 4 to 5 cm. The needle must be deflected and guided very carefully so that it will not impinge upon the bone. The operator soon learns to tell whether or not the needle is in the canal by the ease with which it passes and the direction which it takes. Should it pass just over and to one side of the canal roof, the error will be detectable by observing its direction and by the fact that it passes with difficulty. Also, if it is improperly inserted, the tissues at the end of the needle will be infiltrated

with solution as soon as the injection is started. The sacrum varies considerably in size, shape, and capacity of the canal in different individuals, and a careful study of the osteology, as well as the course of the nerves, is a necessary preliminary.

When the needle is in the canal, its end should be carefully observed to see if either blood or spinal fluid runs out. If so, the needle is withdrawn to a point where the blood or spinal fluid ceases to appear, and the injection made very slowly. If the solution runs in easily from the syringe, the operator may be sure that the needle is in the canal. If, however, the injection is made with difficulty, he may be sure that the needle is not in the canal, and the tissues over the sacrum should be observed for evidences of infiltration.

*The solution* used in our work is freshly prepared novocaine solution—50 to 60 cc. of a 1 per cent solution, or 30 cc. of a 2 per cent solution usually being injected into the canal. No adrenalin is used because we believe it increases the toxicity of the solution without any compensating advantages.

The injection into the canal is extradural, and presumably elevates the dura from the bone under the pressure used.

The next step is to inject a 1 or 2 per cent solution of novocaine into some or all of the sacral foramina (*first, second, and third on each side*) in accordance with the method of Labat. There will be little difficulty in locating the foramina if the needle is passed into the depression just below the transverse processes, and if it is pointed mesially and slightly upward, they will ordinarily be entered without trouble. From 3 to 5 cc. of a 1 per cent solution, or 2 to 3 cc. of a 2 per cent solution should be injected into each foramen, the needle being slowly withdrawn so that the solution may be distributed throughout the entire length of the foramen.

The patient is placed on his back, and fully 30 minutes allowed to elapse before the operation is begun. By this time, that part of the body *which would rest upon the saddle, were the patient on horseback*—including the scrotum, urethra, and base of the bladder—should be thoroughly anesthetized, otherwise the injection is unsuccessful. We have found that if the operation is started too soon, the patient will often feel pain, and such an apprehensive state of mind will be produced that every movement will cause complaint. On the other hand, if one waits until thorough anesthetization has taken place, the patient will go through the operation without a protest.

**After-care Following Spinal or Sacral Anesthesia** Any form of spinal anesthesia requires that the patient remain in the Trendelenburg position for at least 6 hours so that the anesthesia will not reach the vital brain centers and cause respiratory failure. The patient should be instructed to keep his head flat on the bed in order to prevent a severe headache. A hair pillow should be strapped to the head of the bed to prevent the patient's head from coming in contact with the bars when he is placed in shock position. At the end of 6 hours the patient is placed in the horizontal position and maintained thus for 12 hours.

The blood pressure should be taken every hour for from 4 to 6 hours after operation in order to detect symptoms of shock or hemorrhage. Elderly patients, particularly, should be turned from side to side while in the Trendelenburg and horizontal positions to prevent hypostatic pneumonia and to stimulate the circulation as a preventive against the formation of thrombi. Shallow and irregular respirations may be changed to deep regular respirations by 5 minute inhalations of oxygen and carbon dioxide at frequent intervals. If abdominal distention occurs it may be relieved by frequent turning, the use of a rectal tube, small carminative enemas or intramuscular injections of 1 cc. of pitressin, or 1 cc. of prostigmin 1:4000.

Sedatives are usually ordered for the first two days after operation for pain or restlessness. Hot, clear fluids are allowed on the day of operation if they are tolerated. Milk and orange juice are interdicted.

### E. LOCAL INFILTRATION ANESTHESIA

Local infiltration of the tissues to be operated upon, by a suitable anesthetic drug, has been practiced for many years. The process differs from the mere local application of an anesthetizing substance in that a definite plan of reaching certain nerve fibers must be mapped out before hand, the exact location of these nerve tracts determined and their relation to the operative area carefully studied. In practice, this method has come to be called *local* in contradistinction to the more distant nerve blocking, as in the parasacral and brachial methods.

In urology, the infiltration method is used largely for short procedures which do not require relaxation such as hydrocelectomy or circumcision in healthy, young patients. It is possible, however, to use it for major surgery. The method is useful in certain emergency procedures—for example, prostatectomy—in greatly debilitated patients. It is frequently used to supplement regional block or general inhalation anes-

thetia While its greatest usefulness, in major procedures, is in combination with other forms of anesthesia, every urologist will now and again find that local infiltration anesthesia serves him well as his sole dependence in complicated emergencies

*Advantages and Disadvantages* The chief advantage of local infiltration anesthesia is the fact that there is absolutely no added burden placed upon an already overtaxed heart and vascular system Hemorrhage is much less than under a general inhalation anesthetic, and post operative gastrointestinal complications are altogether eliminated When operation must be done immediately, and suitable facilities for regional or block methods cannot be commanded, local infiltration anesthesia may well turn the scale in favor of the patient's survival

It has, however, the disadvantage of a conscious patient

*Anesthetic Drugs Employed* In the early days of its employment, the usefulness of the infiltration method was restricted by two important factors the concentration of the drug employed, and the completeness with which this drug infiltrated the tissues Cocaine derivatives of greater toxicity were used at that period, and it was to be expected that the stronger the solution of the drug the more efficient it would be in dulling the sensibility of the nerves with which it was put in direct contact Continued experiment, however, demonstrated that weaker solutions, properly applied so that the tissues were thoroughly infiltrated and for a considerable distance away from the field of operation, were just as effective and far less dangerous, if one waited a suitable length of time for them to take effect

We now have a number of cocaine derivatives for local infiltration which are comparatively non toxic In our practice, we prefer novocaine, 1 per cent

## F LOCAL ANESTHESIA FOR INTRAURETHRAL PROCEDURES

As a considerable part of the average urologist's practice involves minor interventions, knowledge of local anesthetics suitable for use in routine examinations and office procedures is of quite as much importance as familiarity with the anesthetic requirements of operating room procedures

*Drugs Employed* Cocaine long the standard local anesthetic, has now been largely superseded by less toxic modifications Some urologists, however, use a 10 per cent solution of cocaine routinely, provided there is no open lesion

Novocaine remains the favorite drug for local work in the urethra, but nupercaine, tutocaine, alypin, apothesis, holocaine, and salicaine all have their advocates. Butyn has many good points, but is very toxic in contact with raw surfaces and can therefore be used only if the urethral mucosa is intact.

Isocaine, a procaine derivative, has been recommended as a urethral anesthetic by at least one prominent urological center. A 1 per cent solution of isocaine has proved a satisfactory local anesthetic for the average urethral inspection in most cases rendering the mucosa insensitive long enough to permit completion of a routine cystoscopic examination. No toxic after effects or local irritation have followed its use.

Neothestin has given satisfaction to many urologists who have reported their results. It is supplied in the form of an odorless white powder, readily soluble in water, chloroform, and alcohol, is easy to handle and may be added to such antiseptics as pyridium or mercurochrome thus making it possible to anesthetize and irrigate antiseptically with the same solution. Another advantage of neothestin is that it remains permanent in its power when exposed to air, its solutions being stable and retaining their potency after sterilization by boiling.

Diothane is especially recommended as a urethral anesthetic by its advocates because it does not irritate the mucous membrane even in strong solution. Claims are made for diothane that it is of lower toxicity than any of the commonly used urethral anesthetics nupercaine alone excepted. Our experience with diothane has not, however, led us to change our usual method of anesthetizing the urethra for instrumentation. We have found that its toxicity is out of proportion to the degree of anesthesia which it produces.

Larocaine, first used by European surgeons in 1929, has been found satisfactory by a number of urologists for surface infiltration, and conduction anesthesia. It is supplied in the form of a white crystalline powder and is soluble in water. Solutions are made with distilled water or physiological salt solution and sterilized by boiling. Kemkes reporting on the use of larocaine as a surface anesthetic in about 80 urological cases, found that 10 to 15 cc. of a 0.75 per cent solution, injected into the male urethra, produced satisfactory anesthesia in 10 minutes. The bladder was completely anesthetized 10 minutes after the instillation of 30 to 55 cc. of a 0.75 per cent solution, so that electrocautery operations could be done without pain. No local irritation, toxicity, or other by effects have been observed from the use of larocaine, and its advocates

claim that its effect is as pronounced and more prolonged than that induced by cocaine

Novocaine borate and metycaine are the anesthetics which we have found most effective for cystoscopic and other intraurethral manipulations. Novocaine borate is a combination of crystals of novocaine with boric acid. No other agent tried by us has shown the same property of "speeding up" the anesthesia. Novocaine alone is most effective, but it is slow in taking effect, so that in a busy clinic the work may be seriously impeded because of the length of time required for the preparation of each patient. Novocaine borate, 2 per cent will induce insensibility of the urethral mucous membrane in no more than 2 or 3 minutes, so that by the time the cystoscopist has regulated his armamentarium his patient will be ready for the examination.

**Technic of Administration** The administration of local anesthesia for urethral instrumentation, though comparatively simple, requires considerable care. When an aqueous solution is used, the solution is instilled into the bladder and urethra with a urethral syringe, a clamp placed upon the meatus, and the patient kept recumbent, with the pelvis slightly elevated, for the required period. Painting the solution directly upon the mucous surface is also done. Cotton or gauze impregnated with the solution, or a lubricating jelly into which the anesthetic agent has been incorporated, may be inserted into the urethra. No one of these methods can be guaranteed as infallible, for the examiner can never be certain that every nerve end in the urethral mucosa has come in contact with the anesthetic.

For this reason, neurotic or otherwise hypersensitive patients and young children, who cannot be expected to cooperate, will usually do better under a general anesthetic such as gas-oxygen. In other cases, regional—particularly spinal—anesthesia, or intravenous anesthesia with sodium pentothal, may be preferable.

## G INTRAVENOUS ANESTHESIA

**Advantages and Disadvantages** Intravenous anesthesia, with evipal or pentothal sodium has been satisfactorily employed in short urological procedures, such as cystoscopy, incision and drainage of abscesses, hydrocelectomy, the insertion of radium applicators, especially radon seeds in the bladder or prostate, the cauterization of ulcers, new growths, or redundant tissue, and, occasionally, transurethral resection.

As an adjuvant, it has also a field of usefulness in urology in carefully

selected cases. In operations requiring considerable time, intravenous anesthesia may serve as an effective auxiliary for prolonging the narcosis when spinal or sacral block is being used. It is also useful as an inductive agent, to be followed by general inhalation anesthesia. When administered by the fractional method, which is considered less dangerous than injecting the entire amount at one time, it is very satisfactory because of the rapid, smooth induction, ease of administration, and usual prompt recovery. It is contraindicated in cases of severe renal insufficiency, cardiovascular disease, hypertension, sepsis, anemia, and senility.

A disadvantage of all intravenous anesthesia is the fact that it is uncontrollable.

**Evipal.** Evipal has been highly praised by many urologists as an ideal anesthetic for short, minor procedures and as a valuable auxiliary means of inducing anesthesia. In Italy it has been satisfactorily employed for induction, and both here and abroad it has served, in small graduated doses, as a complement to spinal or other regional methods as employed in cystoscopic work. Evipal may cause alarming falls in blood pressure, and may predispose to shock in major procedures. It should never be administered unless a thorough physical examination has been given the patient.

Evipal sodium, or evipan as it is called everywhere except in the United States and Canada, was isolated in 1932 by Kropp and Taub while making experiments on barbituric acid derivatives. The sodium salt is a water soluble powder, usually supplied in 1 gram ampoules. These are dissolved at the time of employment, so as to form a 10 per cent solution for intravenous injection.

For a 5 to 10 minute narcosis, from 3.5 to 5 cc. is sufficient to put the patient to sleep, so that he wakes without any recollection beyond the prick of the needle through which the injection was made. There is no excitement nor resistance, no lowering of the pulse rate, and but little fall in blood pressure (5 to 20 mm. of mercury), with rapid return to normal. The patient wakes naturally but is drowsy, often sleeping again for some length of time if undisturbed as there is absolutely no postoperative nausea, headache, or other distress. No attention need be paid to the condition of the alimentary tract, the amount of food recently ingested, or the dietetic habits of the patient. This freedom from gastrointestinal effects makes it a particularly useful anesthetic for office work. Preliminary sedative medication is unnecessary, in fact, morphine deepens and prolongs the action of the drug and makes its use that much more hazardous.



**Pentothal.** Allied to evipal sodium is pentothal sodium, which was isolated in 1935 and is now much more frequently used than evipal for intravenous anesthesia in urological work. It is considered superior to evipal in that it does not produce coughing, which has sometimes occurred when evipal has been employed, nor does it induce a rapid change in the intravesical pressure, due to cough or other spasm—a result which may seriously hamper an operator using the cystoscope for examination or operation. Pentothal, therefore, has proved peculiarly adapted to the needs of the cystoscopist. It also serves admirably as an auxiliary for prolonging the narcosis induced by spinal or sacral anesthesia.

Pentothal sodium, like evipal sodium, is a water-soluble powder, supplied in 1 gram ampoules. It is usually employed in a 5 per cent solution for intravenous anesthesia, an average of 10 to 20 cc being injected (1 gram of pentothal sodium to 20 cc of water).

Fractioning the dose is considered less dangerous than administration of the entire amount at one time, for the individual reaction to this drug varies greatly.

#### H. SUMMARY OF ANESTHETIC PRACTICE IN AUTHORS' CLINIC

The following tabulation shows, in a very general way, the preferred types of anesthetics for various urological procedures, as used in our clinic.

<i>Operative Area</i>	<i>Operation</i>	<i>Anesthesia</i>
Young children	All operations and intra-urethral manipulations	General inhalation
PENIS	Circumcision and dorsal slit	1 Local infiltration (novocaine, 1 per cent) 2 General inhalation
	Incision and drainage	1 General inhalation 2 Intravenous pentothal
	Amputation of penis	1 Local infiltration 2 Spinal 3 General inhalation
URETHRA	Intraurethral manipulations	1 Local (novocaine borate, metycaine) 2 Intravenous pentothal 3 Spinal or sacral 4 General inhalation

<i>Operative Area</i>	<i>Operation</i>	<i>Anesthesia</i>
	Internal and external urethrotomy	1 Spinal 2 Sacral and (or) parasacral 3 General inhalation
	<i>Plastic operations</i>	1 Spinal 2 General inhalation
COWPER'S GLANDS		1 Spinal 2 Sacral and (or) parasacral 3 Intravenous pentothal (for incision and drainage of abscess)
TESTICLES, EPIDIDYMES, VASA DEFERENTIA		1 Spinal 2 Local infiltration 3 Avertin (with gas) 4 General inhalation
SEMINAL VESICLES		1 Spinal 2 Sacral and (or) parasacral 3 General inhalation
PROSTATE	Suprapubic prostatectomy	1 Low spinal 2 General inhalation
	Perineal prostatectomy	1 Low spinal 2 Sacral and parasacral 3 General inhalation
	Transurethral resection	1 Low spinal 2 Sacral and parasacral 3 General inhalation (nitrous oxide)
	Other procedures	1 Low spinal 2 Sacral, parasacral 3 General inhalation
BLADDER	Suprapubic operations	1 Spinal 2 General inhalation 3 Local infiltration
	Cystoscopy	1 Local (novocaine borate, metycaïne) 2 Intravenous pentothal 3 Low spinal or sacral 4 General inhalation

<i>Operative Area</i>	<i>Operation</i>	<i>Anesthesia</i>
URETERS		1 Spinal 2 General inhalation (with or without basal avertin)
KIDNEYS		1 Spinal (novocaine, pontocaine, nupercaine) 2 General inhalation

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## CHAPTER VII

### EMBRYOLOGY, ANATOMY, ANOMALIES, AND PHYSIOLOGY OF THE PENIS

#### A. EMBRYOLOGY OF THE PENIS

During the early part of intrauterine life the development of the external genitals proceeds similarly in both sexes, so that for the first 5 or 6 weeks they are in the "indifferent" or sexless stage. In the seventh week, when the embryo is about 16 mm long, they begin to take the form of male or female.

For purposes of description, the development of the external genitals has been divided by certain embryologists into three periods: (1) the genital tubercle period, (2) the phallus period, (3) the final or transitional period, during which the male (or female) organs assume their distinctive form.

**Genital Tubercle Period** Very early in embryonic life the cloacal membrane bisects sagittally an area lying between the umbilical cord and the primitive tail, upon the embryo's ventral surface. It is in this area that the external genitals arise. In embryos 8 mm long, the cloacal membrane is divided into a cranial and a caudal portion, these lie in grooves called the *urethral groove* and the *anal pit* respectively. The urethral groove bisects a small conical tuberosity, the *genital tubercle*.

In embryos 11 mm long, the genital tubercle appears as a rounded eminence occupying the midline of the ventral surface between the umbilical cord and tail. On its caudal slope it bears the shallow urethral groove, the slightly elevated margins of which constitute the *urethral folds*. The urethral groove is separated from the anal pit by a transverse ridge, and cranially the tubercle is marked off from the umbilical cord by a deepening of the intervening groove. Lateral depressions, beginning at the base of the tubercle's apex, converge and unite in the midline to form a longitudinal groove extending to the anal border, sharply differentiating the apex from the rest of the tubercle. On the outer side of this Y shaped groove lateral areas of swelling are visible.

At about the 12 to 13 mm stage, the phallic portion of the urogenital

sinus opens through to the exterior by splitting of the urogenital membrane to form a trough, and the *primitive urogenital opening* thus comes into existence

Sex differences begin to be evident at the 16-mm stage, when the male may be distinguished by the greater length of the urethral groove

**The Phallus Period** The second, or so-called phallus period, begins when the embryo is 17 to 20 mm long (seventh week). The genital tubercle elongates into a cylindrical *phallus*. At its base, on either side, are rounded lateral ridges, the *labioscrotal swellings*, which are separated from the phallus by a groove. Extending almost the entire length of the phallus is the urogenital opening, a narrow orifice with a pronounced epithelial tag above. The urethral folds are more prominent than in the earlier stage.

The glans penis is formed by the gradual downgrowth of a sort of collar of epithelium, which remains incomplete on the caudal aspect. A groove, the *coronary sulcus*, marks off the glans from the base of the phallus.

No pronounced changes occur until the embryo is about 40 mm long, when the male genitalia begin rapidly to assume their distinctive form, while those of the female lag behind.

**Final Period** In the male embryo the phallus now rapidly enlarges and elongates to form the penis. During this process the primitive urogenital opening, which remains in close apposition to the coronary sulcus distally, is removed farther and farther from the anus by the fusing of the caudal ends of the urethral folds in the midline. The fused margins of these folds constitute the *perineal* and *penile raphe*. As the phallus lengthens, the upper part of the urogenital sinus, from which the external genitalia of both sexes originate, likewise grows longer and eventually becomes the major portion of the penile urethra.

Paired columns of mesenchyme come into existence and form the *corpora cavernosa penis*, and the gradual adherence of unpaired bodies in the glans and shaft of the phallus forms the *corpus spongiosum urethrae*.

During elongation of the phallus the labioscrotal swellings gradually migrate downward and assume their permanent position at the base of the phallus, where they eventually come to lie on either side of the raphe, this portion of which is henceforth designated the *scrotal raphe*. Although united in the midline, the bilateral origin of these two scrotal swellings always remains plainly evident.



The coronary sulcus is now a wide groove, delimiting the glans from the body of the phallus

It is at this stage that the male external genitals may be said to have assumed their permanent form, subsequent changes being merely those of size and development. The genital tubercle has become the body and glans of the penis, and the labioscrotal swellings the scrotum

Further fusion of the urethral folds and development of the penile raphe result in closure of the primitive urogenital opening and formation of the floor of the spongy urethra. The glandular portion of the urethra (*fossa navicularis*) develops independently from the solid urethral plate, which bisects the inferior surface of the glans. When the embryo is 105 mm long, this plate deepens to form a groove, which eventually becomes tubular and fuses with the distal end of the pendulous urethra to form a continuous canal, which opens at the tip of the glans

**Development of the Prepuce** The prepuce begins to develop when the embryo is about 60 mm long. Observation has disclosed that in a 10 weeks old embryo there is no definite prepuce, but a thick layer of epidermis covers the glans, which has already been marked off from the body of the phallus by the coronary sulcus. This layer of actively growing epidermis dips down solidly at the root of the glans, thence growing forward over the glans to form an inverted fold. The surface which originally was superficial thereupon becomes the deep portion, facing the surface of the glans. The glans and the developing fold are blended and continuous as a tissue, and the area representing the future preputial space is filled with epidermal cells. The glans at this stage, therefore, is not free from the prepuce, being united with it by unbroken ranks of epidermal cells

At the point where the preputial downgrowth fails, on the inferior surface, connection still remains between the glans and the prepuce, thus establishing the *frenum*. This persists in the fully developed male fetus as a tough fibrous band connecting the prepuce with the lower margin of the urethral meatus

Subsequent desquamation of the cells of the surface layers results in separation of the prepuce and glans, and the prepuce becomes freely movable upon the glans, the condition in which it is normally found in the newborn. Separation probably does not commence until late in fetal life and may be incomplete at birth. The so called adherent prepuce often seen in male children is due to incomplete breaking down of the

preputial epidermic plug, and is therefore a developmental anomaly and not due to pathological adhesions, as is commonly supposed

## B. ANATOMY OF THE PENIS

**Size and General Structure** When it has reached its full development in the adult, the penis is ordinarily about 8 to 10 cm when flaccid and almost double that length in the erect state

Fully two thirds of the organ is composed of the *corpora cavernosa*, two cylindrical bodies of vascular erectile tissue enclosed in strong fibrous sheaths, which lie side by side in its dorsal portion. Beneath, in the angle formed by their apposition, lies a third and smaller body, the *corpus spongiosum*, which has been aptly described as bearing to the corpora cavernosa the same relation that a ramrod does to the double barrel of a gun. The corpora cavernosa are but slightly separated in front, their extremities being blunt and cone shaped, but behind they are separated widely, beginning at the crura of the penis. Elsewhere they lie closely united

The corpus spongiosum is also composed of erectile tissue, and, like its neighbors is surrounded by a tough fibrous sheath, the *tunica albuginea*. Through its sponge like tissue passes the urethra. The entire corpus is divided into three sections the *bulb*, *body*, and *glans*. The bulb lies in the angle formed by the crura of the corpora cavernosa at the point where they come together, and is attached to the lower surface of the triangular ligament. The body lies in the groove between the corpora cavernosa, and is surrounded by the bulbocavernosus muscle. The highly sensitive glans is an expansion of the distal end of the corpus spongiosum which spreads over the dorsal surface of the body, forming a conical cap. It has a well defined and somewhat elevated border, the *corona glandis*, which projects dorsally and laterally beyond the extremities of the corpora cavernosa. Behind the corona is a depression, usually termed the *cervix glandis*, or *coronary sulcus*. The glans as well as the corpus spongiosum proper, is pierced by the urethra, which finds an outlet in the *meatus urinarius*, a vertical linear opening at the summit of the glans.

**Integuments of the Penis** External to the tunica albuginea, the fibro-elastic sheath already mentioned as encasing the corpora cavernosa and the corpus spongiosum, is another elastic sheath which binds all three bodies together and completely invests the rounded extremities of the corpora cavernosa. This is known as *Buck's fascia*, or the *fascia*

*penis* It is firmly attached to the base of the glans, and at the angle of the penis fuses with the fibers of the suspensory ligament anteriorly and the deep layer of the superficial fascia posteriorly. Above this, and just beneath the external skin, lies a loose layer of fatless areolar tissue containing a delicate layer of unstriated muscle fibers called the *dartos*, which is continuous with the dartos of the scrotum. It extends between the two layers of skin which form the prepuce, and its muscle fibers compose the *sphincter of the prepuce*. The outer integument of the penis differs from the general body skin in that it is devoid of fat and hair except at the base of the organ, and in its extraordinary mobility. It extends beyond the glans to form the prepuce.

*Prepuce* The prepuce, or foreskin, is the retractable prolongation downward upon the glans of the delicate, freely movable outer covering of the penis. Normally, it extends forward far enough to cover the glans almost completely. Thence it folds back upon itself, having an attachment at the coronary sulcus, and passes forward over the glans until it reaches the meatal mucous membrane. A small median fold passes from the prepuce to the lower angle of the meatus, forming a tough fibrous band known as the *frenum preputii*, through which courses a small artery. At the preputial orifice the subcutaneous layer is more highly developed than at any other point. The inner surface of the prepuce, as well as the covering of the glans, is delicate in structure, moist, and resembles mucous membrane, although actually it is epithelial in formation.

Sometimes minute sebaceous glands are found in variable numbers on the glans and inner surface of the prepuce. These preputial glands secrete smegma preputii, a fatty white material which collects behind the corona. The smegma bacillus is frequently mistaken for the tubercle bacillus.

*Suspensory Ligament.* The suspensory ligament is a triangular bundle of elastic fibers, attached to the anterior surface of the symphysis pubis at the lower part of the linea alba and to the corpora cavernosa at their angle of junction. It extends to the fibrous capsule of the penis just anterior to the location of the pubic bones, where it blends with this fascial sheath.

*Muscles of the Penis* The muscles of the penis are of great physiological importance. Chief among them are the *ischiocavernosus* (erector penis) on each side and the *bulbocavernosus* (accelerator urinae). The ischiocavernosus has its origin at the ischiatic tuberosity and its insertion

in the sides and under portion of the fascia covering the corpus cavernosum. Its principal function is to exercise pressure upon the veins, thus increasing turgescence. The bulbocavernosus arises from the central point of the perineum and passes upward and forward, completely surrounding the bulb. By forcible contraction, it aids in the evacuation of the urine and applies force to the semen as it is ejected from the posterior urethra. It also exerts pressure on the veins of the corpus spongiosum, aiding in erection.

In addition to these chief muscles, there are unstripped muscle fibers in the erectile tissue and urethra.

**Blood Vessels** *Arteries* The blood supply of the penis is exceedingly abundant. This, with its highly intricate innervation, makes it capable of regeneration even under most unfavorable conditions—an important consideration when operation is to be done upon this organ or when it has been so severely injured as to make the possibility of its preservation uncertain.

The blood supply is derived from the internal pudendal artery. The main trunk enters the perineal region at the base of the urogenital triangle about a half inch below the symphysis pubis. Here it splits into two divisions, one known as the *deep artery of the penis* and the other as the *dorsal artery of the penis*. From the point of bifurcation, the deep penile artery pursues a course down the center of the crus penis until it reaches and enters the tissues of the corpus cavernosum, of which it forms the blood supply. The dorsal penile artery passes between the two crura and is carried forward until it reaches the dorsum, its course lying between the two strata of the suspensory ligament. Passing along the dorsum, this artery proceeds downward to its termination in several smaller branches which form the blood supply of the glans penis.

*Veins* Like the arteries, the veins of the penis are classified as *superficial* and *deep*. The *superficial dorsal veins* serve to drain the small vessels of the prepuce emptying in their turn into the external superficial pudendal veins. Numerous small veins of the glans and prepuce unite to form the *deep dorsal vein of the penis*. This vein runs in the median line, between the strata of the suspensory ligament, passes beneath the arcuate ligament of the pubis and terminates in the pudendal plexus.

**Nerves** In nomenclature, as well as in anatomical distribution, the penile nerves follow the blood supply, their course being practically identical with that described for the arteries and veins. The innervation

of the integument of the penis, and of the ischiocavernosus, bulbocavernosus, and transverse perineal muscles, is derived from the muscular branches of the perineal nerve, which arises from the internal pudendal. The dorsal nerves of the penis accompany the dorsal artery. When it reaches the root of the penis several small branches are given off to form the nerve supply of the corpus cavernosum of that side.

**Lymphatics** A knowledge of the lymphatic connections of the penis is most important to the surgeon because of the frequency of infections and malignant disease of the penis, metastasis from the latter being common and taking place along the line of the lymph channels.

The lymphatics of the penis, in common with those of the scrotum, thigh, and lower part of the abdomen, are part of one system draining into the lymph nodes of Scarpa's triangle and the inguinal area. They form a superficial and a deep network. Of these nodes the most deeply situated are three which lie at the point of union of the external saphenous and femoral veins and in the crural canal. Into these deep nodes empty the lymphatics from the glans penis, as well as the vessels from the nodes lying higher up. The deep inguinal nodes must be kept in mind as possible receptacles for metastasis in malignancy of the penis, for from this group the glands of the pelvis may become involved.

The lymphatics of the penis may be divided into three groups (1) those of its skin and subcutaneous tissue, draining into the superficial inguinal nodes, which in turn anastomose with the deep inguinal nodes, (2) those of the glans penis, which drain into the deep inguinal nodes and in turn anastomose with the external iliac group of the pelvis, (3) those of the urethra, which drain into the deep inguinal nodes with the lymphatics of the glans. There is also another lymphatic system which passes over the symphysis pubis and reaches the external iliac group by a direct route.

### C ANOMALIES OF THE PENIS

Anomalies of the penis and prepuce, with the exception of hypospadias and congenital phimosis are rare though it is not unreasonable to suppose that such malformations may be considerably more frequent than the paucity of the literature on the subject would indicate. Malformations of this organ are likely to be associated with marked abnormalities in other parts of the body, generally incompatible with life, or are found in those of deficient mentality. Should the victim of such a misfortune reach manhood, he will usually do his utmost to conceal the unusual

structure of his external genitalia, and the anomaly will only be observed when he is forced to undergo examination for some related or unrelated condition

Malformations of the penis are caused by maldevelopment of the genital tubercle and phallus and of those sections of the urogenital sinus involved in the formation of the external genitalia. Arrests of development or abnormal formations may take place at any stage of the embryological process

Such anomalies as absent, concealed, or double penis are of slight significance except to those in search of medical curiosities. Of far more importance from the point of view of the clinician are those congenital or acquired deformities of the penis which are more frequently encountered and are amenable to surgical correction

### *Absence of the Penis*

Complete congenital absence of the penis has been recorded only 8 times, and must be reckoned among the rarest of congenital anomalies. The condition must be differentiated from pseudohermaphroditism and concealed penis. In those individuals who have reached manhood without any attention having been given to the anomalous condition, the urinary meatus has usually occupied the normal position of the penis or urination has been through an opening into the rectum.

The best account of congenital absence of the penis that has come to our attention is that of Drury and Schwarzell (1935)

### *Concealed Penis*

Concealed penis may be mistaken for entire absence of the organ, but thorough examination later reveals at least a rudimentary penis hidden beneath the scrotal or perineal skin.

A plastic operation has successfully remedied this condition in several instances where it was unaccompanied by other deformities incompatible with life.

### *Adherent Penis*

Attachment of the scrotum to the under surface of the penis is sometimes seen—usually, but not always, in association with hypospadias. It causes marked incurvation of the penis and may interfere seriously with coitus.

**Treatment** Treatment consists in severing the adhesions, as far as necessary to liberate and straighten the penis, and suturing the skin

### *Double Penis*

Double penis, or diphallus, may be total, or only the glans may be duplicated. About 30 cases, of all types, have been reported. It is invariably associated with other anomalies, and the accessory organ is seldom functionally perfect.

In Donald's case, the anomaly was associated with imperforate anus for which immediate operation was done. The child died within a week of birth, and a full autopsy was made. Each penis was well formed, complete with prepuce and glans, and separate from its fellow in its entire extent. The left was larger and longer, and through it, urine was voided. The scrotum was cleft, and contained a palpable testicle in each half. Dissection revealed absence of the urethra in the right penis. The organ resembled a single corpus cavernosum and was attached by a single crus to the right ischiopubic ramus. On the left side both crura were attached to the left ischiopubic ramus. In addition to the penile anomaly and the imperforate anus, there was complete absence of the right kidney and ureter.

Kimura's patient also had an imperforate anus. There were two independent penes extending to the symphysis, with separate tips but covered with a common skin. The glans of each organ appeared through a separate foreskin. Each glans had a urethral meatus, through which urine passed. On each side was a scrotum, containing an apparently normal testicle. Radiograms, with x ray catheters, showed an uninterrupted passage to the bladder from the lower penis, but the upper catheter impinged upon the lower instrument 7 cm. from the meatus, the passage of urine through both catheters indicating that there was union into a single urethral lumen before the bladder was reached. This was later confirmed at autopsy. Immediately behind the double penis, between the two scrotums, was a swelling which resembled a third scrotum but contained no testicle. The infant died on the twenty fifth day of life, and autopsy revealed the additional anomalies of duplicate heart chambers, three lobes in the left lung, and absence of the spleen.

An interesting case of double penis was seen by Corrado during the course of an official autopsy upon a hunchback, aged 38 years, who had died suddenly without assignable cause. There were two complete

penes, 7 to 8 cm long, and without prepuces. The meatuses were slightly hypospadiac. The normal scrotums contained a single normal testicle each. At the internal side of the implantation of each scrotum was an anal orifice which opened into a rectum, of which there were two. There was no anus at the usual site. Each penis contained a single corpus cavernosum, which was attached to the corresponding ischiopubic ramus and enveloped the corpus spongiosum, and was directed toward the vesical neck. The two urethras opened into a reduplicated bladder, each half of the double bladder having a ureter opening into it. Above, both the urinary and intestinal tracts were normal. There was a small but distinct prostate on the left side, on the right the prostate was represented only by a small lump the size of a pea. On each side was a small seminal vesicle and vas deferens. There was separation of the pubic bones of about 10 cm and the rest of the skeleton was much deformed, the man having been hunchbacked from birth.

Nesbit and Bromme's patient had reduplication of the bladder and of the glans, each glans being provided with a frenum but having a rudimentary meatus, the urine passing out through two narrow clefts, one on each side of the base of the penis.

In Seth and Peacock's case the normally situated penis showed a slight hypospadias, the accessory organ had no prepuce or urethra, and the meatus was only suggested by a depression.

In a case presented by Professor Behdjat Sabit Erduran, of Istamboul, at the Deutsch Gesellschaft für Urologie, in 1926, there was no urethra in the accessory penis and a urethral fistula was present on the other side.

### *Congenital Phimosis*

Phimosis implies a preputial orifice so small in relation to the size of the glans as to prevent retraction of the prepuce behind the glans. Distinction must be made between the congenital form in which narrowing of the orifice is the result of maldevelopment, and the acquired form (p. 252), in which the constriction is dependent upon inflammatory or other irritative factors.

Distinction must also be made between true phimosis and simple redundancy of the prepuce, a condition which may, however, have an important bearing on the production of the acquired form. The term "phimosis" has come to be rather loosely applied to long foreskins in general whether or not they can be retracted. When phimosis is present, the prepuce cannot be retracted, whereas a redundant foreskin can be



retracted so long as no inflammatory or other pathological state (usually induced by the abnormal length of the prepuce) arises to prevent it. A redundant prepuce, even if it is not originally adherent, may easily become so, due to the collection beneath it of secretions and foreign material.

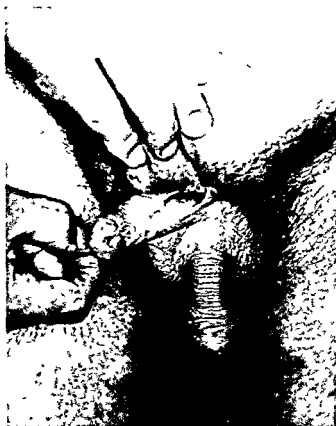


FIG. 33 Double penis. The lower (accessory) penis had no urethra. The other organ had a urethral fistula near the penoscrotal junction, through which the urine passed. (Courtesy of Professor Behdjet Sabit Erduran)

**Types of Congenital Phimosis.** The terms *hypertrophic* and *atrophic* are commonly used to differentiate two forms of phimosis. In the hypertrophic type, the prepuce is of sufficient length to cover the glans, but the orifice is too small. In the atrophic form, the prepuce is not only short but the opening is too narrow. A third form, which is usually classed under congenital anomalies, is that produced by adhesions between the glans and the prepuce. In young infants these can often

be severed by the obstetrician's finger, causing little or no bleeding. This simple procedure may frequently dispense with the necessity of performing circumcision.

**Effects of Phimosis** In many cases of true phimosis the physician is not consulted until some complicating condition has arisen to direct attention especially to it. Inability to retract the prepuce favors the collection beneath it of smegma and other irritating secretions, and uncleanness often leads to distressing conditions. Balanoposthitis and venereal warts are common complications, and recurrent attacks may lead to extensive adhesions between the apposing surfaces, so that even the small amount of retraction originally possible will be permanently abolished. Phimosis also predisposes to the formation of preputial stones and to cancer of the penis. Sometimes the preputial orifice is so narrowed as to obstruct urination, the resulting back pressure producing changes in the urinary tract similar to those caused by a strictured urethra or an hypertrophied prostate.

The local irritation caused by phimosis or an adherent prepuce is frequently productive of the enuresis, vesical irritability, and masturbatory habits of childhood.

**Treatment.** Treatment of true phimosis is usually circumcision (p. 319).

Sometimes, however, dorsal incision upon a grooved director will satisfactorily open up a tight preputial orifice. The edges of the V-shaped opening are then sutured, leaving a permanent widening sufficiently ample to permit free retraction of the prepuce.

Circumcision is being done with increasing frequency upon children of non-Hebraic parentage, with the idea that many diseases of the external genitalia may thereby be avoided. It is a question however, how often the prepuce should be removed in very young children. It is normal for the foreskin to be relatively longer in infants than in adults, and it may well be that what appears a redundant prepuce at 20 days may be only a proper investment for the glans at 20 years, when full growth has taken place and the proper balance between the prepuce and the glans has been struck.

### *Hypospadias*

Hypospadias is a congenital defect of the anterior urethra, the canal terminating at some point upon the under side of the penis instead of at the tip of the glans. It is a fairly common anomaly, being seen about

once in 350 subjects, and is frequently associated in its severer grades with other malformations of the genital organs, such as cleft scrotum,

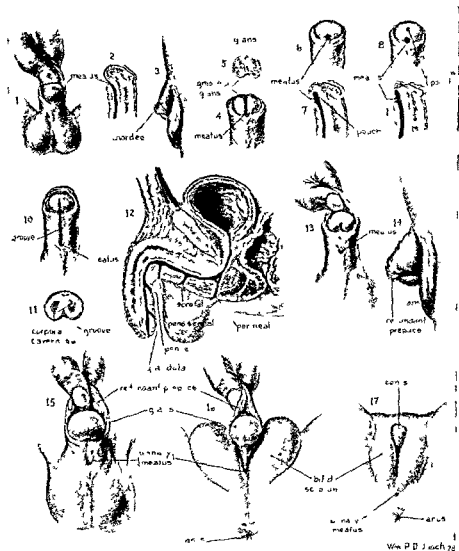


FIG 34 Various grades of hypospadias, from the simplest type (1, 2, 3) in which the urinary meatus is slightly misplaced downward, to the perineal type (17) in which the meatus is just in front of the anus and the penis is bent almost double. Types of glandular hypospadias (1 to 9) Penile hypospadias (10, 11, 13, 14) Penoscrotal (15), scrotal (16), and perineal (17) hypospadias View 12 is a composite drawing showing the different grades of hypospadias as determined by the location of the urinary meatus

incurvation of the penis, rudimentary penis, congenital hernia, or cryptorchidism

**Etiology.** Hypospadias is due to imperfect closure of the urethral

groove, the margins of which normally fuse in the median line to form the urethral floor. Arrest may take place at any point in this closing process, producing hypospadias in its various degrees.

**Types of Hypospadias** There are three main types of hypospadias: the glandular, the penile (penoscrotal), and the perineal (perineoscrotal).

**Glandular Hypospadias** In the glandular type, the urethral opening is in the glans but somewhat below its normal location—generally at the point where the frenum (which is absent) is attached. Occasionally there are two or even more openings. The glandular urethra is absent, an open groove usually occupying its normal position. The glans is broader and flatter than ordinary and is usually imperforate, though it may be pierced by an opening which is separated from the urethra by a blind sac. The prepuce is short and thick at the dorsum of the glans, but becomes thinner as it approaches the urethral meatus. In adults, the penis will be more or less deflected downward at the point where the hypospadias begins. Glandular hypospadias usually causes little inconvenience.

**Penile Hypospadias** In penile hypospadias, the urethral opening may be found at any point along the floor of the penis between the glans and the penoscrotal junction. The orifice is oval instead of the transverse slit usually observed in the glandular type. The urethral canal rarely extends beyond the point of opening, a groove upon the surface marking its normal route. Exceptionally there may be a perfect canal anterior to the anomalous opening, but the meatus at the tip of the glans will be imperforate or much strictured. When the hypospadiac opening is at the penoscrotal junction, the penis is usually small and incurved upon the scrotum to which it may be partly adherent. Sometimes the scrotum is completely cleft, and the corpora cavernosa likewise may be separated.

**Perineal Hypospadias** Perineal hypospadias, the most severe grade, is the hardest to remedy. Fortunately, it is also the rarest. Associated malformation of the external genitals is marked. The anomalous meatus is usually situated about 3 or 4 cm. from the anus, being a slit-like opening in the groove which divides the scrotum into two parts. Labia-like folds of mucocutaneous tissue lie on each side of this orifice, giving it somewhat the appearance of a small vagina. Each half of the cleft scrotum may contain a testicle, which is often atrophied, or, as frequently happens, the scrotum may be undeveloped and the testicles retained in the abdomen. The penis is small and almost hidden by the scrotal folds. As a rule, the urethra continues as a groove for some distance beyond the

anomalous opening on the floor of the shortened and incurved penis, and may end as a blind sac at any point along its normal course, but the tip of the glans is always imperforate

In the extreme form, which is often termed pseudohermaphrodisism, it may be very difficult to determine the sex of the individual because of the similarity to the female external genitalia, the dwarfed penis resembling an enlarged clitoris and the cleft scrotum the labia majora

**Effects of Hypospadias** In glandular and penile hypospadias, despite the penile deformity, the urinary stream can usually be directed so as not to wet the clothing, but it is extremely difficult for the unfortunate victims of the perineal type to keep themselves clean and free from an objectionable ever present odor of urine. In urinating, they must sit down to avoid wetting the clothing, owing to the force with which the urinary stream is projected from the membranous and prostatic portions of the urethra, which do not share in the deformity

Sexual intercourse is possible in the glandular and penile types, but in perineal hypospadias coitus is impossible, and in most of the penile cases the urethral opening is so far from the glans as to bring it outside the vagina, thereby preventing impregnation. The deformity thus becomes a source of great mental distress to many adults even though its concealment is much more easily accomplished than is the case with epispadias

**Treatment.** Operations for the repair of hypospadias are described on page 335

### *Epispadias*

In epispadias, the urethra lies above the corpora cavernosa and opens on the upper surface of the penis at some point behind its normal ending. The roof of the canal is wholly or partially lacking. The condition may or may not be accompanied by incontinence of urine, or by partial or complete exstrophy

The amount of space devoted to this anomaly in medical literature would lead one to assume that it is relatively common. Actually it is so rare that cases are seldom seen more than once or twice in the professional life of even a specializing urologist. It occurs once to about 150 cases of hypospadias, and is much more common in males than in females. In its severest form it is frequently associated with other anomalies, such as exstrophy of the bladder, absence of the prostate gland, congenital hernia, or cryptorchidism



been offered as to how the corpora cavernosa came to lie above the corpus spongiosum. Perhaps the most commonly held theory is that it is due to an embryonic displacement upward of the cloacal membrane before formation of the genital tubercle, the tubercle later arising below the membrane, so that eventually the urogenital sinus comes to open on the dorsum of the phallus. Most embryologists believe that epispadias and exstrophy are gradations of the same embryological defect (Exstrophy, Etiology, p. 962).

**Types of Epispadias** Epispadias in the male is of three degrees: the *glandular*, the *penile*, and the *complete*.

**Glandular Epispadias** Glandular epispadias, the simplest of the male forms, is unfortunately the rarest, only a few cases being on record. The urethral orifice is situated on the upper surface of the glans or at the level of the coronary sulcus. The penis is of normal form, though shorter than usual, and has a "spread out" appearance. The glandular urethra is represented by a groove. Exceptionally, the glans has been found completely cleft.

**Penile Epispadias** In the penile form, which is also very uncommon, the urethra opens on the upper surface of the penis at some point between the glans and the symphysis pubis, most commonly just in front of the symphysis. The penis is seldom more than 1 or 2 inches long and describes a decided upward curve. Upon its dorsal surface is a wide furrow with rounded edges and lined with mucous membrane, this ends in a deep funnel shaped pocket partly concealed by the overhanging folds of abdominal integument. If any part of the normal urethra is present, it usually has a fair sized lumen and the posterior portions of the corpora cavernosa are well developed. The prostate, however, is usually absent, and in only a small percentage of cases is the corpus spongiosum present, the bulb being always very small.

**Complete Epispadias** Complete epispadias is the most common of the three forms, and is usually combined with that most distressing of all urogenital anomalies, exstrophy of the bladder. The penis is rudimentary and curved upward against the pubis. The urethra lies open for its whole extent up to the bladder, and its opening is large, infundibuliform, and usually concealed by an overhanging fold of abdominal tissue and by the penis, which curves upward against it.

**Effects of Epispadias** Incontinence of urine is usually present in some degree, and is always complete when there is involvement of the

posterior urethra and external sphincter. Due to the upward curve of the penis, the urinary stream is directed vertically, so that the pubis is constantly bathed with urine, and from infancy the skin of the supra pubic region is likely to be in a constant state of excoriation and even of severe ulceration. The brevity and deformity of the penis render coitus difficult even in the most favorable cases. Usually it is impossible. Should sexual connection take place, the fact that the seminal fluid must be ejected at the penopubic junction practically always defeats impregnation.

In childhood, the discomfort and mental distress occasioned by his inability to control the urine may affect the child's entire outlook, and the sexual difficulties that come with adolescence cause such psychic disturbance as to justify almost any effort at remedying this distressing condition, despite the difficulties attending such attempts.

**Treatment.** The surgical treatment of epispadias in the male is described on page 347.

### *Congenital Cysts and Canals of the Penoscrotoperineal Raphe*

**Etiology.** Congenital cysts and canals of the raphe are uncommon. They are believed to arise either from epithelial embryonic rests which have persisted because of defective closure of the urethral folds or (Johnson's theory) from outgrowths which have split off the embryonal epithelium after closure of the folds.

In normal development, the margins of the urethral groove fuse in the midline to form the urethra. It is conceivable that in this process rests might be enclosed which would appear, in postnatal life, as cysts or fistulas, depending on whether or not they communicated with the surface. Such cysts or canals are lined with epithelium continuous with that of the canal itself or of identical structure. In other words, they have an epidermoid or mucous lining, depending on their cells of origin. Congenital canals of the raphe are apparently always lined with stratified squamous epithelium.

**Symptoms and Diagnosis.** Both cysts and furrows may be found at any point along the raphe, but only when they attain unusual size or become infected do they cause inconvenience. Such infection is usually gonorrheal. Ordinarily, they are discovered accidentally during examination for other purposes.

**Treatment.** In most instances they are best left alone, but if suppuration occurs or if a cyst attains a size sufficient to cause pressure on the



urethra or otherwise produce disturbing abnormal manifestations, surgical removal is necessary

#### D PHYSIOLOGY OF THE PENIS

The penis is primarily a sexual and secondarily a urinary organ, and its complex and highly specialized structure, as we have shown in the section on anatomy, is adapted to fulfill these two functions, particularly the genital

**Mechanism of Erection** Regarding the anatomicophysiological processes involved in the production of erections Howell states that during erection the penis becomes hard and erect, owing to an engorgement with blood, and that the structure of the corpora cavernosa and corpus spongiosum, being composed of relatively large spaces enclosed in trabeculae of connective and plain muscle tissue, is peculiarly adapted to this act Eckhard demonstrated the essential facts in the process when he discovered that, in the dog, stimulation of the *nervi erigentes* causes erection These nerves are composed of autonomic fibers arising from the sacral spinal nerves (first to third, dog) on each side and help to form the pelvic plexus Eckhard, Loven and others have shown that when these fibers are stimulated there is a large dilatation of the arterioles in the erectile tissue of the penis and a greatly augmented blood flow to the organ

The act of erection is, therefore due essentially to a vascular dilatation of the small arteries whereby the cavernous spaces become filled with blood under considerable pressure and are distended to the limits permitted by their tough fibrous wall It seems probable that the rigidity is completed by a partial occlusion of the venous outflow, which is effected by a compression of the efferent vein by means of the extrinsic muscles (*ischiocavernosus* and *bulbocavernosus*) and possibly by the intrinsic musculature as well

Howell believes that this explanation of the act of erection, undoubtedly correct so far as it goes, leaves undetermined the means by which the dilatation of the small arteries is produced and that some points in the actual mechanism of the dilatation still require investigation

According to Marshall the erection of the penis is brought about partly through the contraction of the *ischiocavernosus* and *bulbocavernosus* muscles, certain of the fibers of which pass over the efferent vessels and so arrest the outward flow of blood Henderson and Raepke suggest

that skeletal ischiocavernosus muscular contractions may play some minor part in erection of the penis

Samson Wright does not mention the role of the ischiocavernosus or the bulbocavernosus muscles in connection with the causation of erection, nor does C. Lovatt Evans in his revised edition of Starling's *Principles of Human Physiology*

It appears, from a review of the literature, that later writers are less certain of the role of the ischiocavernosus and bulbocavernosus muscles in the production of erections. The experimental work of Lowsley indicates that they are of great importance, that tightening the ischiocavernosus on each side and the bulbocavernosus, in dogs, produces erections which are under control of the dog's mind. Fear, strange surroundings, and other psychological factors cause disappearance of the erections, while return of the dog to his canine companions restores them. Removal of these three muscles, in dogs, results in elimination of the power of having erections even under the strong influence of a female dog in heat, proving the contention of those physiologists who claim that these muscles play important roles in producing penile erections.

The innervation and blood supply of the penis are described in the section on Anatomy (p. 228). The nerves which supply the bulbocavernosus and ischiocavernosus muscles are of especial physiological interest because of the important part they play in the mechanism of erection. The turgescence which is part of the phenomenon of erection is made possible by the action of the nerves upon the blood vessels, to which they bear so close a relation, assisted by the muscular mechanism of the penis. The fine twigs, which run to the papillae of the glans from the larger trunk accompanying the dorsal artery, are distributed so as to afford a maximum of tactile sensation to the glans.

The physiology of urination is discussed under Physiology of the Bladder (p. 974).

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## CHAPTER VIII

### INJURIES AND DISEASES OF THE PENIS

#### A INJURIES OF THE PENIS

##### *Wounds*

**Gunshot Wounds** Gunshot wounds of the penis, apart from war injuries are uncommon. Numerous instances are on record of gunshot and shell fragment wounds incurred during World War I. Some of these were very extensive, ranging from severe laceration of the penile tissues to complete severance or destruction of the organ, usually in association with trauma to the neighboring structures.

**Incised Wounds** Incised wounds if not very deep heal quickly provided they receive prompt attention. From deep wounds involving the erectile tissue there will be very free hemorrhage, and loss of erectile power in the area anterior to the wound often follows. If the penis has been completely severed the hemorrhage may be so great as to prove rapidly fatal unless hemostasis can immediately be established.

**Lacerated Wounds** Lacerated wounds of the penis are quite common in modern industrial life and are sometimes very extensive. An unusual case is that reported by Peters. The victim was seen 50 years after infliction of the original injury. When 20 years of age, he had been struck upon the penis by an exploding dynamite cap, which split the organ in half from the meatus to the symphysis, dividing the urethra longitudinally and forming a urinary meatus at the penoscrotal junction. There had been left two separate dependent structures, their inner aspects covered with the mucous membrane of the urethral lining and their outer surfaces with penile skin. Perfect healing had ensued; the 'accidental' meatus functioned perfectly, and the general health had been unaffected. Erection had, however, always been feeble and infrequent and intromission impossible.

Ehrich's patient was the victim of a circular saw which had cut into the left side of his scrotum, completely exposing the testicles and splitting the left gland. The penis was severed behind the sulcus except for a thin strand of tissue on the dorsum and was denuded, the wound extend

ing through the mons veneris and into the abdominal wall. The severed urethra and ruptured tunica of the corpora cavernosa were repaired. Enough scrotal integument remained to cover the undamaged right testicle, and after removal of the injured left testicle, that side of the scrotum, with the remains of the prepuce, was used to make a slip graft for the penis. The result was a normal appearing penis though a trifle shorter in erection than usual. The urethra was slightly strictured

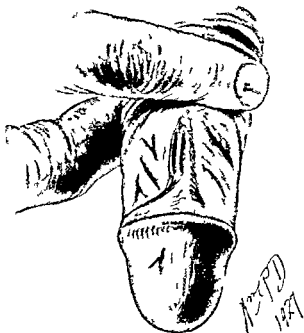


FIG. 36. Incised wound of the penis.

at the point of repair, but function was not seriously impaired. Neither impotence nor sterility resulted, and when seen, 2 years later, the man had become a father.

A case of severe laceration of the penis, said to have been due to an attempt to have intercourse through a barbed wire fence, came to our attention when a number of sailors were held in quarantine for a long period during an epidemic of influenza.

**Punctured Wounds** Punctured wounds are infrequent, and are usually caused by bayonet or sword thrusts or by falling on a pointed object

**Treatment of Wounds** If made by revolver bullets, gunshot wounds are often sterile and quite clean, and will heal without attention other than maintenance of asepsis, elevation and support of the parts by a suitable suspensory, cold applications, and administration of a prophylactic dose of antitetanus serum

Severe hemorrhage is always controlled by ligation, but mere venous oozing can usually be checked simply by apposing the cut surfaces by pressure with gauze pads, or by introducing a hard rubber catheter into the urethra and swathing the penis tightly in a roller bandage. If the blood vessels of the corpora cavernosa have been injured, incision will frequently be necessary to evacuate the clots and ligate bleeding points. A catheter is always left in the urethra and the penis bandaged firmly (but not constrictively) and supported. The catheter is removed at the end of the second day. Erections may be prevented by the administration of sedatives or opiates.

The application of heat in the form of hot compresses hastens the absorption of coagulated blood in the tissues. If a large hematoma forms, incision and drainage may be required.

When the urethra has been severed, it should be united over a catheter and the urine diverted by a drain introduced into the bladder through a suprapubic incision. This can usually be removed at the end of a week. In less severe injuries of the urethra, a retention catheter may be all that will be necessary.

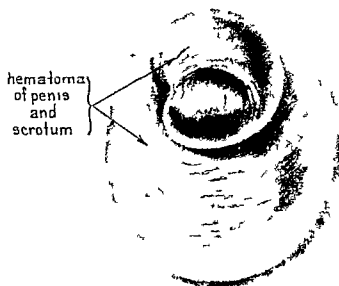
Punctured wounds should always be incised, to establish adequate drainage and avoid infection. Antitetanus serum is usually administered as a precautionary measure.

Most surgeons attempt to save the penis even when it has been almost completely severed and there is likelihood that healing may result in contracture by cicatricial tissue to an extent sufficient to interfere with function. Because of the abundant blood supply, successful repair of extensive and seemingly hopeless wounds is common, and the great progress made in plastic surgery of these parts in recent years offers encouragement in even the gravest injuries.

### *Contusions*

By "contusions" of the penis we imply a milder and superficial traumatization of the tissues as distinguished from rupture, or deep seated in-

injury, of the organ. Contusions are incurred usually, when the penis is in the erect state. They are the results of direct violence, such as blows, kicks, falls, or squeezing. The contusions may cause merely a slight localized ecchymosis, or rupture of the subcutaneous vessels may produce such extensive hemorrhage and extravasation into the loose subcutaneous tissues as to simulate a rapid gangrenous process. In the



Wm P Didusch 1937

FIG. 3/ Hematoma of the penis and scrotum caused by slight contu on

more severe cases sloughing and infection are not uncommon sequelae. Though the swelling and discoloration may be alarming in their extent, there is usually little pain unless the urethra or cavernous bodies have been injured.

**Treatment** Rest, elevation of the parts, and hot compresses to promote absorption are usually all that is necessary. Incision will be necessary if the hematoma assumes unusual size or if there is evidence of suppuration.



*Rupture (Fracture) of the Penis*

Rupture of the penis is a deep seated injury to the organ while in the erect state, involving the tunica albuginea of the cavernous bodies and sometimes the corpora proper and causing extravasation of blood into the subcutaneous tissues. The condition is also referred to as "fracture," although fracture in the ordinary sense is impossible, the penis being a muscular and not a bony structure. If the penis is traumatized while in its flaccid state, nothing more serious than a subcutaneous ecchymosis is likely to result.

**Etiology** The tunica albuginea encasing each corpus becomes considerably stretched during erection of the penis, and consequently thinner, making it more susceptible to rupture. The injury may involve only the tunica of one or more of the three corpora, or it may affect the corpora cavernosa proper, or there may be injury to the urethra.

Rupture of the penis is usually the result of (1) violence or injury during coitus—the most common cause, (2) sudden contact of the penis, while erect, with a hard object such as a piece of furniture, (3) rough handling, or (4) attempts to break a chordee.

**Symptoms and Diagnosis** Pain is extreme, often causing the victim to faint and leaving him in little doubt as to the gravity of his injury. He usually tells of having heard a sharp cracking sound resembling the breaking of a glass rod, followed at once by collapse of the erection and pain. If seen immediately after the injury, the penis will show a "bent" place, much as if it actually were composed of bone. There is rapid engorgement of the tissues, discoloration, and swelling, sometimes of alarming proportions. The ecchymosis may extend beyond the genitalia, over the thighs and upon the abdomen. The acute pain subsides, to be succeeded by a dull ache which gradually increases in intensity unless prompt treatment is instituted.

If the urethra has been injured, blood will appear at the meatus. Severe laceration of the canal may produce complete urinary retention, but as a rule only slight dysuria is complained of.

Examination shortly after the accident will generally reveal a soft and flaccid penis, but if more time has elapsed the extravasated blood will have been partially absorbed and there will be palpable a cord like structure beneath the indurated and sensitive tunica albuginea.

Establishing the diagnosis of ruptured penis is usually a fairly simple matter, but determining the exact location and extent of the rupture may be more difficult. Reticence may deter the victim from seeking advice until marked swelling has set in, making examination difficult. But the

history, intense pain, hematoma, and swelling are usually sufficient to establish the diagnosis and to distinguish deep-seated injury from mild contusions

**Treatment.** Simple rupture, without injury to the urethra, is often satisfactorily treated by immobilization and elevation of the penis, and cold applications to stop bleeding followed by hot compresses to promote absorption. If there is not rapid improvement, an incision should be made, with strict asepsis, and bleeding vessels ligated. Large hematomas require evacuation of their contents. Incision is also demanded at the first indication of emphysema or suppuration.

The method of supporting the external genitals by strips of adhesive plaster carried underneath the genitals and attached to the thighs is very useful in such injuries.

In cases with urethral involvement, a catheter should be passed to the bladder and allowed to remain in position for a week or longer. Occasionally it may be found impossible to pass a catheter from the meatus upward, in which event a suprapubic incision should be made and retrograde catheterization done. If necessary, the urine may be diverted through a suprapubic incision until the lacerations have healed.

**Prognosis.** As in all penile injuries, a certain psychic element must be taken into consideration. The patient will suffer forebodings regarding loss of potency and sexual ability, and the prognosis should be guarded. Actually, it depends upon the urethral injuries and the extent of the hemorrhage, which is frequently so severe as to necessitate incision for the evacuation of clots and repair of the lacerated tunics. Should this be neglected, suppurative hematoma or even gangrene might supervene.

### *Denudation of the Penis*

Complete denudation of the penis has been occasionally reported. In a case presented by Powers, a 6-year-old boy was caught in a barbed wire fence and the penile skin completely everted so that it appeared to have been 'peeled off much as one would evert the finger of a glove in removing it.' The skin was replaced, and after some sloughing and a rather protracted convalescence, the wound healed perfectly, the skin being freely movable, the base of the penis unconstricted and the appearance practically normal.

In the case reported by Counsellor and Palmer, the patient fell astride a rapidly moving pulley and was carried several times around the shaft. The penis was entirely denuded and two thirds of the scrotum torn away. Tannic acid dressings were applied for 3 days, followed by vaseline

dressings and immersion of the genitals several times daily in normal salt solution. One month after the accident, the entire denuded area was covered by healthy granulations, which were removed and Thiersch grafts from the thigh applied. The end result was a penis practically normal in appearance and function.

### *Constriction of the Penis*

Constriction of the penis, from various causes, occurs quite frequently, and the resulting swelling and injury to the blood vessels may lead to serious consequences, even gangrene and loss of the organ. Urinary fistulas and damage to the upper urinary tract by back pressure are some times serious sequelae.

Numerous instances are on record where metal rings have been slipped on over the shaft, the resulting edema soon preventing their removal.

Too tight bandaging may also produce marked edema.

A superstition exists among certain people that a wedding ring slipped over the penis of one suffering from acute gonorrhea will have a curative effect. We have seen two cases of constricted penis resulting from this practice. One patient had put an engagement ring on his penis with the hope that it would cure his acute gonorrhea. It was removed, with considerable difficulty, before any great damage had been done. The second patient, an ignorant Italian, had slipped his wedding ring over his penis, and the entire distal portion of the organ became gangrenous before the ring was removed.

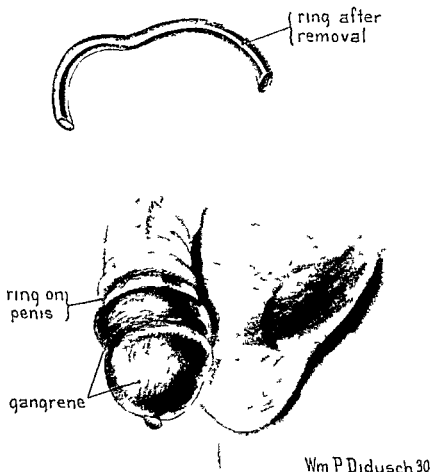
In a third case of constriction seen by us a young child had had a thread tied around his penis by a lazy nursemaid because he wet his clothes too often. The thread had become buried in the edematous tissues, and by the time the distracted parents sought medical aid it had already cut into the tissues of the penis sufficiently to cause permanent injury.

**Treatment.** Treatment is removal of the constricting body (not always an easy feat), followed by the application of wet dressings until the edema has disappeared, a return to normal conditions usually following. Ulceration, however, may result in a circular scar, interfering with erection. Injuries to the urethra, of course, must be repaired.

### *Dislocation of the Penis*

Violent trauma may cause dislocation of the penis. The skin remains in position, but its attachment behind the glans is torn free so that the penis is forced backward beneath the skin of the scrotum, perineum, pubis, or groin. If the urethra is ruptured, as it usually is, extravasation of urine will greatly complicate the situation.

**Treatment** All blood clots must be removed, the penis reduced to its normal position at the earliest moment, and the results of trauma repaired. If extravasation has occurred, perineal section must be performed immediately and drainage instituted.



Wm P Didusch 30

FIG 38 Constriction of the penis with gangrene of the terminal portion caused by a wedding ring slipped on the penis. The ring was removed by filing. The glans penis sloughed away.

## B DISEASES OF THE PENIS

### *Acquired Phimosis*

Phimosis—that is, abnormal narrowing of the preputial opening so as to prevent retraction of the prepuce behind the glans—may be either congenital (p 232) or acquired.

**Etiology** The acquired form occurs in adults, and may be due to a number of causes (1) inflammation or trauma, with destruction of the elastic fibers of the prepuce and the formation of permanent scar tissue, which subsequently contracts, (2) acute edema or inflammation, which, when it subsides, again permits retraction of the prepuce, (3) chronic irritation, such as that due to dribbling of urine in prostatic obstruction or paralysis of the bladder. The inflammatory type is usually due to venereal infection, or to uncleanly habits, resulting in the collection of smegma and other irritating secretions—a condition favored by a long prepuce.

**Treatment** As the causes of acquired phimosis are varied so the relief measures will differ according to the etiology and the degree of phimosis present. In very mild cases instructions as to physical care and cleanliness may be all that is required. If there is active inflammation, irrigation of the preputial sac with mild antiseptics and hot applications will be necessary to allay the inflammation and reduce the edema. Frequently, when this has been accomplished, retraction of the prepuce will again be possible without further treatment except the maintenance of cleanliness.

Chancroid if present, must be treated by the proper measures (p. 264). In most cases it will be necessary to slit the prepuce, dividing it as accurately as possible in the axial line directly over the site of the chancroid or other lesion to be treated. Complete circumcision is unwise in the presence of such virulent infection, as the organisms would be disseminated, and the raw edges of the wound offer an excellent site for their propagation. When the infection has cleared up circumcision may be performed.

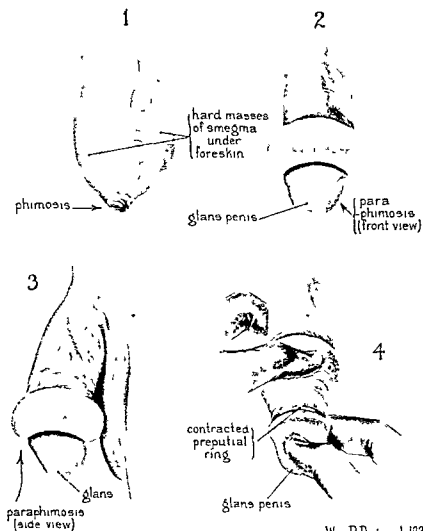
In the more severe cases, where phimosis has been induced by cicatricial contraction following healing, a dorsal slit, or complete circumcision (p. 319) will be necessary.

### *Paraphimosis*

Paraphimosis (Figs. 39 and 40) implies a condition in which undue pressure or strangulation is exerted upon the glans penis by the prepuce, which cannot be reduced from its retracted position behind the glans. It necessarily implies a certain degree of phimosis congenital or acquired, but if the phimosis is so great as completely to prevent retraction of the prepuce, then paraphimosis cannot occur.

It is frequently a complication of inflammatory conditions such as acute gonorrhea, balanitis, chancroid and chancre.

**Symptoms.** The tight preputial opening is halted at a point directly behind the glans, so that a constriction is formed about its entire cir-



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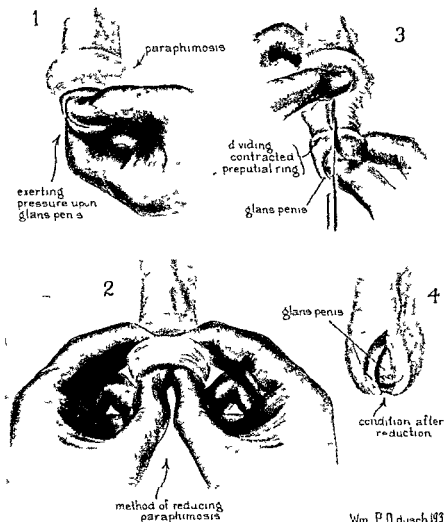
FIG 39 Phimosis and paraphimosis.

cumference The glans rapidly becomes swollen, tense, and discolored, and the prepuce markedly edematous

**Treatment.** Paraphimosis is usually an urgent condition which forbids prolonged consideration of the ultimate results of the methods taken to relieve it Gangrene, though rare, may result from too much

"watchful waiting" Surgical division of the constricting band may be necessary, but attempts at reduction should first be made

The first step is to reduce the edema sufficiently to permit replacement of the prepuce (Fig 40) By gentle but steady manual compres-



Wm P Dusch 1931

FIG 40 (1, 2) Reduction of paraphimosis (3, 4) Dorsal slit, necessary when paraphimosis cannot be reduced by manipulation

sion over the point of constriction, most of the edema may be forced back along the penile shaft. The second step is to bring the prepuce forward over the glans. Using both hands, the surgeon takes a firm hold on each side of the penis behind the point of constriction. The second finger of each hand supports the shaft below, the first fingers are passed

behind the stricture above, while the thumbs compress the glans on both sides at the same time endeavoring to push the prepuce forward. The idea should be not so much to force the glans backward as to push the prepuce forward and over the glans to a position where it will not be constrictive. The traction is, therefore, more important than the pressure.

Irrigation with a mild antiseptic and the use of a suspensory for a few days is all the after treatment necessary.

If the paraphimosis cannot be reduced, recourse must be had to the dorsal or lateral slit (Fig. 40). The constricting band and the edematous folds of tissue behind it should be incised. Circumcision may be performed after the swelling subsides.

The after care consists in keeping the parts scrupulously clean and supported until healing is complete.

### *Cutaneous Affections*

The skin of the penis, in common with that of other portions of the external genitalia, is subject to a variety of parasitic and other cutaneous affections. These and their treatment are discussed under Cutaneous Affections in the section devoted to diseases of the scrotum (p. 414).

#### *Urticaria of the Penis (Protein Sensitization)*

Urticaria (hives) occasionally occurs on the penis. The characteristic wheal appears on the epidermis of the penile shaft as a rule, but has been seen on the mucous membrane in patients circumcised in early infancy.

**Diagnosis.** The lesion is recognized easily enough if the possibility of urticaria occurring in this location is borne in mind, but the rarity of this manifestation makes it unlikely to be thought of, and there may therefore be some difficulty in making the diagnosis. A carefully elicited history will usually reveal a previously noted protein sensitization. If the patient has suffered from hives in the past, the likelihood of the penile lesions being due to the same cause is very strong.

**Treatment.** Treatment consists in elimination of the offending protein, which must be accomplished by the usual routine tests for sensitization.

#### *Balanitis and Balanoposthitis*

Balanitis is a superficial inflammation of the glans penis. In most cases the under surface of the prepuce is also affected, the condition then being termed *balanoposthitis*.



**Etiology** Balanitis is frequently a complication of gonorrhea, and, in general, is caused by retention of irritating secretions, a condition favored by a congenitally long prepuce or by uncleanness

*Chronic balanitis* is a less virulent inflammation, which is more likely to appear in middle aged or elderly men in whom the prepuce has become pendulous through muscular relaxation The mucosa of the glans and prepuce eventually becomes thickened, and on retraction of the prepuce will be found to be covered with granulations or even by areas of excoriation

**Symptoms** In balanoposthitis the mucosa of the glans and prepuce becomes damp and red, and there is intense itching and the exudation of an evil smelling creamy white discharge The swelling is sometimes so great as to induce an inflammatory phimosis, and there may be ulcer formation closely simulating chancroid

**Treatment** Cleanliness separation of the glans and prepuce with a layer of gauze, and antiseptic compresses usually afford prompt relief The prepuce should be retracted and the glans and prepuce thoroughly cleansed with a mild disinfectant, such as bichloride of mercury, 1 1,000, oxycyanide of mercury, 1 2,000, or mercurochrome, 1 500

A 'butterfly dressing' is convenient This is made by cutting a hole, just large enough to admit the penis, in the center of a 4 inch square of gauze This is slipped over the organ until the edge about the hole comes directly in the coronary sulcus When the prepuce is drawn over the glans the gauze comes between the surface of the glans and the inner leaf of the prepuce

The gauze should be kept saturated with the antiseptic solution and changed several times daily The penis may be immersed for 15 minutes in the solution, at a temperature of 100°F Pads soaked in lead and opium, or aluminum acetate 10 per cent, may then be applied and covered with an ice bag This will relieve pain and itching and reduce the inflammation

### *Streptococcic Balanopreputial Intertrigo*

Streptococcic balanopreputial intertrigo is a rare transference of infection to the penis from a streptococcic lesion elsewhere on the body

Montgomery describes a case in which infection was transferred from a streptococcic lesion of the left leg The penile lesion was circular, smooth, and distinctly defined and was situated on the right side of the glans the sulcus and the corresponding surface of the prepuce being so placed that when the prepuce was drawn forward the red surface folded

Wm P Dicusch 30

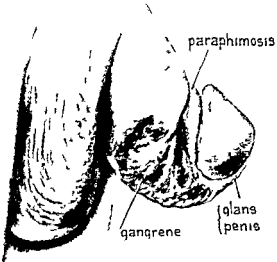
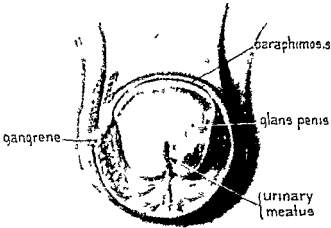


FIG 41 Gangrene of penis caused by paraphimosis

accurately into apposition. A crack, resembling those of athlete's foot, lay in the sulcus, its edge elevated so as to give an impression of rolled induration suggestive of chancre.

Differential diagnosis is only occasionally difficult, and these obscurities can ordinarily be dispelled by the microscope and by a history of streptococcic infection elsewhere.

**Treatment** Such lesions usually clear up readily under the treatment ordinarily applied to erythema of this general type.

### *Erosive and Gangrenous Balanitis*

**Etiology** Erosive and gangrenous balanitis is a specific infectious venereal lesion due to symbiosis of a vibrio and a spirochete. It was first described in 1889 by Bataille and Berdal, and in 1904 the causative organism was isolated and identified by Scherber and Muller, who called the affection "the fourth venereal disease." In this country, Corbus, of Chicago, has been the chief contributor to our knowledge of this pathological entity.

Predisposing factors are a congenitally long and tight foreskin, contamination of the penis with infected saliva, unnatural sexual practices.

**Bacteriology** The bacteriological picture is morphologically identical with that seen in Vincent's angina, noma, or ulcero membranous stomatitis, all of which are affections of the mucous membrane. The vibrio, or fusiform bacillus, is a weakly Gram positive spindle shaped organism showing one or more granules in its central portion. It evinces no motility under the dark field. This form can be grown on ascitic or serum agar under strict anaerobic conditions, where it appears in the form of short rods sometimes filamentous in character.

Compared to the *pallida*, the spirochete mentioned by Corbus is rather thick and possesses great motility, there being both a wave like and a rotary movement. The spirals of which there are usually from 6 to 10, are neither as numerous nor as fine and regular as those of the *Treponema pallidum*.

Both the fusiform bacillus and the spirochete stain readily with dilute carbolfuchsin, another point which distinguishes this spirochete from the *pallida*.

**Pathology and Symptoms** There are two types, or rather degrees, of this disease: the milder form, or *balanitis erosiva circinata*, and the advanced stage, or *balanitis gangrenosa*.

*Balanitis erosiva circinata* begins with small grayish white patches

in the preputial sac, accompanied by a foul, yellowish white discharge. There is considerable burning and itching, and phimosis may soon prevent retraction of the prepuce.

If the patient comes under observation before marked phimosis has developed, retraction of the prepuce and removal of the discharge will disclose small, rounded ulcers within the eroded areas. The ulcers are usually multiple, moderately deep, flat, surrounded by a bright red zone, and covered by an adherent false membrane. In the severer cases, these ulcers become deeper, irregular in outline, and confluent, extending over the whole glans and inner surface of the prepuce. The borders of the ulcers are elevated and sharply differentiated, with slanting sides. The bases are covered by an edematous yellowish membrane which is sometimes replaced by a friable slime if edema is considerable. Here and there may be hemorrhagic spots, which may cause bleeding from the base of the ulcer. If left untreated, gangrene involving the glans and prepuce and sometimes the entire organ may develop.

Balanitis gangrenosa, the advanced stage of the disease, is accompanied by constitutional symptoms such as nausea, vomiting, chills, and elevation of temperature. There is great edema of the subcutaneous tissues of the penis, producing an extreme degree of phimosis and sometimes extending to the root of the organ, and enlarged but not painful inguinal nodes. Urination is usually painless unless there is sufficient phimosis to retard the evacuation of the urine, so that dilatation of the preputial sac results. Ulceration on the inner surface of the prepuce will show externally as a dark, bluish red area surrounded by bright red inflammatory tissue. The discharge is very profuse and offensive, and the congestion and abnormal pressure due to the edema greatly favor the progress of the disease. The prepuce over the ulcer turns black and necrosis rapidly develops. An ulcer on the glans may quickly destroy it completely, and there may be rapid extension of the gangrenous process and destruction of the entire penis.

**Diagnosis** The organisms are abundant in the exudate and they may also be found in the blood vessels and lymph nodes. They are readily demonstrated by ordinary staining methods.

**Differential Diagnosis** The chief infections from which erosive and gangrenous balanitis must be differentiated are syphilis, gonorrhea, and chancroid. Its spirochete, as we have already shown, is easily distinguished from that of syphilis, and the local lesions are quite dissimilar although it must be remembered that the two infections may coexist.

The two glass test is often sufficient to rule out gonorrhea or smears will show the absence of diplococci. However, gonorrhea may exist simultaneously with the balanitis.

The disease with which this form of balanitis is most apt to be confused is chancroid, and microscopy to rule out the Ducrey *Unna bacillus* will be necessary. Although the ulcers of the two infections are similar enough to be frequently confusing, there are certain factors that help to differentiate the diseases. ulcerative balanitis spreads more rapidly, its exudate is more abundant and offensive, the inguinal glands, while enlarged, are painless and do not suppurate as they commonly do in chancroid.

The mild form of erosive balanitis may simulate herpes preputialis, but the characteristic organisms will be absent in herpes.

**Treatment** Since a long foreskin is an absolute prerequisite for the propagation of these anaerobic bacteria, circumcision is the best preventive of this disease.

The mild cases are usually cured by retraction of the prepuce and thorough cleansing, and the application of hydrogen peroxide which, by its liberation of oxygen, is fatal to anaerobic bacteria. When the disease has gained a foothold, all sloughing tissue must be carefully removed, and dressings wet with hydrogen peroxide applied. If retraction of the prepuce is impossible a dorsal slit should be made, so that the infected area may be exposed and treated.

In the rare instances where hydrogen peroxide fails to cure injections of arsphenamine compounds, as they are employed in Vincent's angina, may be necessary, and if gangrene has already set in they should be used in conjunction with the local treatment.

### *Chancroid (Soft Chancre)*

**Etiology and Bacteriology** Chancroid is a contagious self inoculating venereal ulcer of specific origin, situated usually upon the external genitals though it may be extragenital. Its development is favored by filthy habits and surroundings. The causative agent is the Ducrey *Unna bacillus*, a short Gram negative, blunt ended organism occurring in chains or clumps and staining quite readily by the ordinary methods.

The incidence of chancroid in the Negro race, in this country, is much higher than in whites. A recent study of the disease in an Army post where the ratio of colored soldiers to white is about 1 to 5 revealed, during the period of the survey, 73 colored to 3 white primary hospital admissions for Ducrey infection (Greenwald).

**Pathology** The lesions usually appear at the edge of a phimotic prepuce, or on the frenum and in the coronary sulcus, although they may also occur along the penile shaft. The disease begins, 3 to 10 days after exposure, as a small papule, which quickly becomes pustular and breaks down leaving a deep, crater like ulcer with irregular, undermined edges and a granular, grayish base which bleeds easily when touched. The base is covered with a foul smelling, grayish, purulent discharge, in which the organisms may generally be found by staining. The ulcers, which usually appear singly at first, multiply by autoinoculation and spread rapidly, causing widespread destruction of tissue unless treated. As a rule, there is considerable tenderness and pain.

A clinical classification of four varieties of chancroid has been made (1) *Ulcus molle*, the ordinary ulcer, has a characteristic "punched out" appearance, with edges sharply differentiated and often undermined (2) *Ulcus molle miliare* begins as a small papule, but rapidly becomes a pustule with a deep crater like ulcer as its center. This type is most frequently seen just posterior to the mucocutaneous junction of the prepuce in the male and about the labia majora and perineum in the female (3) *Ulcus molle elevatum* the sore most frequently confused with indurated chancre. Its incubation period is from 9 to 29 days. The lesion is slightly raised above a mildly infiltrated base, the edges are not undermined, and it shows little tendency to spread. It is persistent and refractory to ordinary treatment (4) *Ulcus molle phagedenicum* the most severe and persistent form, occurs as a complication of both chancroid and syphilis, spreading rapidly, and capable of destroying part or even all of the penis if allowed to progress unchecked.

**Inguinal Adenitis (Bubo)** Infection with Ducrey's bacillus is often complicated by a suppurative adenitis of the inguinal nodes. The inflammation quickly progresses to abscess-formation which eventually breaks down the tissues and works its way to the surface, emerging through the skin as a chancroid of the groin. This frequently occurs just when the original penile lesion appears to have run its course and is practically healed. The adenitis is painful in the more advanced stages, and occasionally is associated with fever and anorexia. Otherwise, constitutional reaction is rare in chancroid.

*Lymphangitis* frequently accompanies the bubo.

**Diagnosis** Chancroid is diagnosed on its clinical course and appearance, on the Ito Reenstierno skin test, and by the examination of smears and cultures but only after the exclusion of syphilis by repeated dark field

examinations The finding of the Ducrey bacillus in smears and cultures does not rule out syphilis, as the two conditions may be present in the same lesion They may be acquired simultaneously, or one infection may be superimposed upon the other

The smear is the best single criterion of diagnosis, positive identification being possible in over 85 per cent of cases Smears may be made by the Gram method Wright's stain, or methyl green pyronine

Great care is necessary to obtain a good growth of the Ducrey bacillus on blood agar plates, but by using clotted rabbit's blood for primary cultures from the ulcers, and inoculating blood agar plates from the clotted blood after 24 hours incubation, pure cultures may be obtained Criteria for the routine bacteriological identification of the Ducrey bacillus are (1) It is a Gram negative bacillus growing in characteristic long chains, and tangles in clotted rabbit's blood, (2) it forms, on blood agar, characteristic colonies that readily glide over the surface of the medium, (3) it does not grow on any ordinary laboratory cultural medium with the exception of blood agar

It is generally agreed that the skin test is a specific test and is positive in about 75 per cent of cases, but there is disagreement as to the duration of infection before the skin will show an allergic response to the antigen Various writers place the minimum time at from 6 to 10 days to 5 weeks In making the test, 0.1 cc. of a commercial antigen (Lederle Ducrey Vaccine) is inoculated intradermally

*Differential Diagnosis FROM SYPHILITIC CHANCRE* As in all genital ulcers, repeated dark field examinations and Wassermann tests are essential to rule out syphilis, and no treatment of chancroid should ever be instituted until these have been done The diagnosis may be made, as far as possible, from the clinical facts, but it must be confirmed by laboratory methods

Chancroid differs from hard chancre in its shorter incubation period, tendency to multiplicity, the presence of tenderness and pain (syphilitic chancre is painless), lack of induration, irregular edge, and the suppurating nature of the inguinal adenitis However, there are many atypical cases of chancroid, and syphilitic chancre offers such a variety of appearances that it can truly be said there is no typical lesion

A chancroidal sore will most commonly show an undermined edge which rises abruptly from the normal skin and is often irregular, with fissures radiating out into the surrounding area The base is devoid of induration and is usually pitted or covered with a diphtheroid membrane

The discharge is abundant, purulent, sometimes sanguineous. A syphilitic chancre, on the other hand, is more matted together and less flexible, and there is usually the areola at the margin of the erosion. The well defined edge does not rise abruptly from the surrounding skin, but slopes gently away into the adjacent parts, and the contour is round or oval.

These clinical distinctions, though important, are presumptive at best, and the final test must be that of the laboratory.

**FROM EROSION AND GANGRENOUS BALANITIS** Chancroid may also be confused with the lesions of erosive and gangrenous balanitis, which it closely resembles. Both diseases are spread by uncleanness and are more apt to be seen in out patient clinics than in private practice. Both have a predilection for the preputial space, but the anaerobic organisms of erosive and gangrenous balanitis demand a long foreskin and a closed preputial sac for their propagation, and, given these, develop anywhere within the sac, while chancroid is not dependent upon the exclusion of air and prefers the coronary sulcus. In balanitis, the inguinal nodes while enlarged, are painless and do not suppurate as they so often do in chancroid.

**FROM LYMPHOGRANULOMA VENEREUM** Chancroidal bubo must also be differentiated from the adenopathy due to lymphogranuloma venereum (p. 283), the diagnosis of which has been greatly simplified by the Frei test. The two infections may, however, coexist.

**Prophylaxis** The chemical prophylaxis recommended by the Army for venereal disease in general (p. 718) has not proved as efficient against chancroid as against syphilis and gonorrhea.

**Treatment** Prior to the introduction of the sulfonamides, many different types of treatment were utilized for chancroidal infection, most of which have been supplanted by sulfatherapy. A few, however, deserve mention here.

**Formalin Therapy** An efficient method of treating chancroid is by the use of formalin, as described by L. H. Jacobsen in 1935.

The parts involved are anesthetized and the lesion cleansed of all secretion and debris. An undiluted solution of formaldehyde (U.S.P. 37 per cent), commercially known as formalin, is applied to every part of the lesion for from 3 to 5 minutes, the excess formalin and any secretion being then wiped off, and a sterile unctuous dressing applied. For subsequent dressings, Jacobsen suggests an ointment containing 0.5 per cent camphor. One application of formalin usually suffices, but for extensive



ulceration a second or even a third application may be necessary. As formalin has a strong bactericidal action, if applied early enough it will prevent suppurative adenopathy in the inguinal region. The severe pain and distress of advanced cases are relieved at once. Soon after the first application, a crust covers the lesion, beneath which rapid healing takes place.

*For anesthesia*, the local application of cocaine will suffice in superficial lesions seen early. If there is extensive involvement of the penis, so that the prepuce and glans must be treated, sacral block or low spinal anesthesia is preferable.

*Tincture Mercresin Therapy* Another method of treating chancroid, that we have found effective, is the topical application of undiluted tincture mercresin to the ulcers.

*Protein Therapy* Chancroidal infection, uncomplicated by syphilis or diabetes, has been successfully treated in many cases by the intravenous injection of a foreign protein—most frequently Dmelcos Vaccine, a stock French preparation of *Bacillus Ducrey* in physiological salt solution, 225 million per cc. This is administered every other day until cure is obtained (6 to 16 days) the following dosage being given:

First injection	1 0 cc
Second injection	1 5 cc
Third injection	2 0 cc
Fourth injection	2 5 cc
Fifth injection	3 0 cc
Continuing until cure in gradually increasing doses, 0.5 cc more each day, 6 injections usually sufficient to effect a cure	

The injections may be given at night, the patient immediately going to bed. The chills and fever which mark the protein reaction last about 2 hours, after which the patient usually sleeps soundly and feels no ill effects in the morning, except, perhaps, a slight headache (Gorlin).

*Cauterization* An effective method of treatment, when the ulcers tend to become phagedenic, is deep and thorough cauterization with nitric acid (U S P strength) or, in extreme cases, with the actual cautery (preferably under gas oxygen anesthesia). Before treatment is instituted, the ulcers should be sponged off carefully with hydrogen peroxide and dried.

Another method of cauterization is with silver or argyrol crystals. The ulcer is thoroughly cleansed, the crystals applied and covered with a gauze dressing, and the patient left undisturbed until the following day.

except for the necessary evacuations of the bladder. The crystals are applied daily until there is a healthy granulating surface.

*Surgery* In the more severe cases of phimosis a dorsal incision in the prepuce is often necessary, although the wound is likely to become auto-inoculated with chancroid.

Suppurating buboes usually require incision and drainage.

*Sulfonamide Therapy* Most of the older forms of treatment have been replaced by the use of the sulfa drugs, surgery being indicated only for fluctuant buboes or when there is poor exposure and drainage of the penile lesion because of phimosis or paraphimosis.

Four gm daily of sulfathiazole in 4 divided doses (the initial dose 2 gm), continued for a minimum of 7 days, usually effects a cure. There are rarely any dangerous complications although the patient must always be carefully observed for toxic phenomena. The lesions should be soaked twice daily in potassium permanganate 1:8000, followed by the application of sulfanilamide powder.

### *Syphilitic Chancre (Hard Chancre)*

Although syphilis is now recognized as primarily a skin disease with important constitutional sequelae, the usual site of its initial lesion is upon the external genitals, and its early manifestations are within the field of the urologist. Therefore, while urology as a specialty is now carefully differentiated from syphilology, urologists in common with all other medical practitioners come frequently in contact with this disease and its immediate and remote results. It is of the utmost importance that the genital lesions be familiar to every practitioner, for in prompt recognition and immediate vigorous treatment lies our hope of ever controlling this prevalent and destructive disease.

There are three stages of syphilis (1) the primary, (2) the secondary, and (3) the tertiary. The end of the incubation period is marked by the appearance of a *primary* lesion, the chancre, and if the disease is diagnosed and properly treated at this stage, the chances for complete recovery are almost 100 per cent. But, because the chancre is practically painless, many persons fail to apply for treatment. In the *secondary* stage, the germs are distributed by the blood throughout the body, often causing a characteristic, generalized rash (roseola) that brings the patient to the doctor. In many cases, however, the cutaneous eruption may be missing and other constitutional symptoms so mild that they are easily overlooked. The secondary stage occurs from 10 days to 6 or 8 weeks

after the appearance of the primary chancre. The tertiary, and by far the most serious, stage may follow the earlier stages almost immediately, or the syphilitic process may remain dormant for many years. Any part of the body—skin, bones, brain, nervous system, or vital organs—may be attacked, and many deaths attributed to other causes, particularly heart disease, Bright's disease, and paralysis, are undoubtedly due to syphilis. When the disease invades the nervous system, causing paresis, tabes dorsalis, etc., its cure is questionable.

Syphilitic lesions of the various organs of the genito urinary tract are taken up elsewhere in this book, in connection with the diseases of the particular organ.

**Etiology.** Syphilis is due to infection by the *Spirochaeta pallida*, or *Treponema pallidum*, isolated and identified by Schaudinn in 1905. Its primary lesion, the chancre, may be found on any accessible part of the body except the hair, teeth, and nails, but approximately 95 per cent occur on the external genitals.

Syphilis is usually communicated by sexual intercourse, but this is by no means always the case. The infecting organisms, being long lived and able to survive where there is sufficient moisture and absence of air and sunlight, will enter any abrasion in the skin or mucous membrane with which they come in contact. Syphilis, both congenital and acquired, of non venereal etiology forms an important chapter in syphilology. Fournier, in 10,000 cases of chancre, found 6 per cent to be extra genital in men and an even higher percentage in women. The majority of the extragenital chancres occur on the lips.

**Pathology.** The most common site of the genital chancre is the corona glandis, frenulum, or inner surface of the prepuce, but it may also occur on the shaft of the penis, on the scrotum, or just within the urethral meatus. More often than not the chancre will be solitary, but multiple lesions are seen so often that this cannot be regarded as a diagnostic criterion.

The chancre usually appears 10 to 30 days after exposure. The typical chancre usually begins as a hyperemic area which develops into a superficial papule followed by superficial erosion. The lesion slowly but steadily increases in size, and its evolution requires anywhere from 5 days to 6 weeks, although a shorter period is more common. Induration at the base is the rule, and was formerly regarded as positive proof of a syphilitic chancre, but the dark field has revealed *Spirochaeta pallida* in lesions which had neither indurated bases nor rolled edges. In the major-

ity of cases the surface of the chancre is eroded rather than ulcerated, the base clean, and the edges well defined, but there are many atypical cases

Unfortunately, the syphilitic chancre is painless, so that infected persons frequently fail to seek medical advice

In about three fourths of the cases, there is a painless, discrete, non suppurating enlargement of the adjacent lymph nodes, which on palpation are felt to be hard, freely movable and only slightly, if at all sensitive. Periadentitis is minimal or absent

The chancre heals slowly, in from 3 to 8 weeks, and leaves a small, superficial scar or no trace whatever

**Diagnosis** The following five points cannot be too strongly emphasized

(1) Every genital ulcer, in males or females, is syphilitic chancre until disproved by reliable laboratory tests. The laboratory diagnosis of syphilis is indispensable

(2) A specimen should be taken immediately and sent to the laboratory without delay. *Prompt action is imperative*

(3) A clinical diagnosis must never be relied upon, no matter how familiar with the appearances of syphilitic manifestations the practitioner may believe himself to be. The unaided eye *may* be right, the microscope is *certain* to be

(4) No treatment, local or constitutional, should ever be given until the diagnosis has been unquestionably established

(5) The final exclusion of syphilis is not possible until 3 to 4 months from the time the lesion was first seen

Three reliable laboratory methods are available (1) the dark field examination (2) the local Wassermann test, and (3) blood Wassermann reactions. Every practitioner should be familiar with the necessity for these tests, as well as with the interrelation of dark field examination and the Wassermann tests in the diagnosis of syphilis

The Wassermann test does not become positive until at least 2 to 3 weeks after the chancre appears. Dark field examination is applicable in the early period before the Wassermann test becomes positive and will demonstrate the *Spirochaeta pallida* in a high proportion (65 to 70 per cent) of early, untreated lesions. If repeated dark field examinations in a lesion which has had local treatment prove negative, a local Wassermann test should be made. It is these two tests upon which dependence is placed for an early diagnosis of syphilis—that is, a diagnosis made *before* the blood test becomes positive

In larger communities, the general practitioner or urologist who finds a

suspicious lesion on his patient's penis may secure a sufficient specimen for dark field examination and at once submit it to the most convenient laboratory. Then, after warning the patient that the sore may be contagious and cautioning him about taking the customary precautions against infecting his family and associates, the physician can dismiss the patient to await the laboratory report. Laboratories, however, are not to be found at every cross road. In smaller communities, and particularly under the abnormal conditions of war time, the average physician will have to rely upon his State Board of Health, and should know how to obtain and ship specimens to this central laboratory. He should therefore equip himself with suitable capillary tubes for shipping and should acquaint himself with the routine technic of filling the tube

- 1 Remove any granulations or crusts from the lesion
- 2 Wash carefully, to remove any secondary (surface) infection, using sterile water or normal salt solution (no soap or disinfectant)
- 3 Dry with sterile gauze, and with a fresh gauze sponge rub the surface of the lesion until it bleeds slightly or exudes serum. Wipe off the first exudation if bloody. Do not squeeze the lesion unless no clear serum appears spontaneously
- 4 When clear serum appears, use a very small syringe (usually furnished with the capillary tube) to obtain a specimen from the depths of the lesion, rather than from the surface. Serum can also be made to enter the tube directly, by capillary attraction
- 5 Both ends of the tube should be sealed *immediately*, using beeswax softened only by the warmth of the physician's fingers. (Never use heat)
- 6 Put the capillary tube in the outer container provided for mailing or shipping and send *at once* to the laboratory

If the first dark field report is negative, the test should be repeated for 3 days running. If all the reports are negative, the lesion may be considered non syphilitic and suitable local treatment instituted.

If the laboratory reports are repeatedly negative, but clinical evidence of syphilis is strong, it may be necessary to examine specimens from an enlarged lymph node or lesions other than the primary sore upon the penis. To obtain a specimen from a gland

- 1 Secure a Record or well fitting Luer syringe of suitable capacity, fitted with a 20 gauge needle
- 2 Prepare the skin about the gland to be aspirated in the same manner as for local anesthesia; i.e., wash, paint with iodine, and wash off with alcohol

toxicity is less, reactions are fewer (usually entirely absent), and thrombosis of the veins seldom occurs. *Disadvantages* are the technic must be very exact, as slight errors (failure to mix the solution properly, too long standing of the solution, deterioration of the basic drug) will result in grave toxic reactions. More injections are necessary to achieve the same effect as is obtained with arsphenamine. In equal dosage, the efficiency of neoarsphenamine is less than that of arsphenamine, so that it is relatively, as well as actually, the more expensive form of treatment. In general, neoarsphenamine is more unstable and therapeutically efficient than arsphenamine.

3 *Mapharsen* This is a "therapeutically active break down product of all other arsphenamines," and is a later introduction which has been used with good success by the British in the treatment of syphilis as it occurs in the armed services. The method of administration is by multiple daily injections, shortening the usual course of treatment by many weeks and making it possible to give a complete course to members of the armed services who are under the care of any one physician but a relatively short time. It is generally reported that the characteristic lesions heal more rapidly under mapharsen treatment than when neoarsphenamine is used. *Disadvantages* are gastrointestinal reactions, which occur more often than with other arsenicals, and involvement of the central nervous system—although this is perhaps no greater than with arsphenamine and its derivatives.

4 *Medication Other Than Arsenical Derivatives* Reliance cannot be placed upon arsenicals alone if the patient is to be assured of lasting freedom from luetic infection.

*Mercury used to be the practitioner's chief reliance but with improved methods of producing drugs and their compounds, bismuth has largely replaced it.* But as bismuth can only be given satisfactorily by intramuscular injection (a method not possible except under controlled conditions and expert technic), mercury which the patient can rub on himself when incorporated in an ointment still finds considerable employment, especially where hospitals and their facilities are not at hand. Certain patients react from arsenicals by marked dermatitis, making it imperative that they be laid aside entirely. For such, mercury may serve to fill the gap. For elderly patients also, oral administration of mercury and potassium iodide at times proves helpful.

*Bismuth* administered intramuscularly may be (1) soluble in water (tartrate, thio-glycollate), (2) soluble in oil (campho-carboxylate) or

suspendable in oil (subsalcylate, metallic bismuth), (3) soluble in ethylene glycol (sodium iodo-bismuthate)

Those preparations which are soluble in water are absorbed and excreted so rapidly that treatment must be frequently renewed—daily or at least every other day. When oil is the vehicle employed, absorption is slower, but the treatment must be kept up longer and is more expensive than with water soluble preparations. The treatment is likely to be painful. Bismuth subsalcylate, being insoluble, is very slowly absorbed, sometimes as long as three months passing before absorption is complete, but this necessitates no more than one treatment a week and involves no cumulative effects—both marked advantages. As its administration is practically painless and this form can be obtained cheaper than any other, the use of the subsalcylate is very generally recommended. The U S Public Health Service advises using peanut or olive oil as a vehicle for a 10 per cent suspension. The course is from 6 to 12 injections (never more) at 5 to 7 day intervals, using 0.2 Gm. of subsalcylate, *never* metallic bismuth.

*Potassium or sodium iodide* is usually administered in connection with the regular arsenicals or bismuth mercury routine. It is supposed to make the main treatment more effective by increasing the permeability of the tissues and thus hastening the cure of the characteristic lesions. As extended use of iodides is likely to cause unsightly dermatitis, they should be employed with caution.

Of the necessity for combined treatment—arsenicals with bismuth or mercury—Moore, of the U S Public Health Service, has said

The protection of the patient consists in the invariable use of bismuth or mercury in conjunction with arsenical therapy either simultaneously (concurrently) or in alternating courses. Just as no patient should be treated exclusively with an arsenical so also no patient should be treated exclusively with a heavy metal even with bismuth for all that it possesses greater spirocheticidal qualities than mercury. Its inferiority to the arsphenamines in this regard has been clearly demonstrated.

*General Requirements of Treatment* Whatever form of treatment is selected, it must be continuous. Intermittent treatment has been proved as bad if not worse, than no treatment at all. Moore and Kemp, at Johns Hopkins, found that when a lapse in treatment lasting an average of  $7\frac{1}{2}$  months, occurred between the first and second arsphenamin courses, recurrent positive Wassermanns were 10 times as frequent as when treatment had been continued without interruption. Furthermore clinical recurrences of a secondary type developed in 30 patients (11.8 per cent).

treated intermittently, as contrasted with only 6 (2.6 per cent) who received two courses of arsphenamin separated by mercury. A lapse between the second and third treatment courses was also attended by a ten fold incidence of Wassermann recurrences.

*Number of Injections of Arsphenamins Required* Authorities agree that not less than 20, nor more than 30, injections of the arsphenamins are needed to gain a permanently negative Wassermann test—save in especially resistant cases. When this result has been attained, treatment should be continued for one year, with the application of the blood test at the conclusion of each course of treatment. It will be essential that the patient understand that the occurrence of a negative result from the test does *not* mean that the danger is over and all precautions may be dropped. No "rest period" should be permitted until 12 full months of treatment have elapsed. Before such a "rest," a quantitatively titred Wassermann upon the spinal fluid should be made, together with a cell count, the colloidal gold test, and a protein estimation.

*If hen arsphenamin is used*, the first 3 injections are given on the first, fifth, and tenth days, the dosage being 0.1 Gm. for each 25 pounds of body weight. The third week after the initiation of treatment, weekly administration is begun, using dosage of 0.4 Gm. for men (and 0.3 Gm. for women) for a period of 5 weeks. Forty-five days from the beginning of treatment, the patient should have received 8 injections.

An interim treatment of 4 weeks is now carried out, using bismuth, 0.2 Gm. each dose, for 4 weekly doses, with the addition of K I or mercury and potassium iodide together. Arsphenamin is then resumed in weekly dosage through the seventeenth week, when bismuth is again substituted for 6 weeks, in weekly doses of 0.2 Gm. as before, with K I or mercury and potassium iodide. The spinal fluid should be examined at about the twentieth week. Arsphenamin continues through the thirtieth week, then bismuth again for 8 weeks, resuming arsphenamin through the forty-third week, at the end of which time a patient whose blood serologic test has always proved negative may cease treatment. For others, arsphenamin is continued after 10 weeks (from the forty-fourth to the fifty-third week) of bismuth. The next bismuth interval is from the sixtieth to the sixty-ninth week, to be regularly followed by a no treatment period for 1 year, during which monthly blood Wassermanns should be made if possible.

At the end of the second year, a complete physical and neurological examination (including spinal fluid examination) should be made, and



in the years following at least 2 blood tests and yearly check ups should be made

*When neoarsphenamin is used*, the arsenical part of the course should be longer and the intervals shorter. The dosage should be 0.6 Gm. minimum for males (and 0.45 Gm. minimum for females). The maximum for males is 0.9 Gm. (for women, 0.75 Gm.)

*Treatment with Mapharsen*. Because so many patients either cannot or will not undergo the long course of treatment which alone insures them against recurrence and secondary effects, there has been an unremitting search for a therapeutic agent which will be as effective as the arsphenamins while doing its work more quickly. It was hoped that mapharsen would prove such an agent, although it was long ago discarded by Ehrlich and Hata as too toxic for safe administration. In 1935, however, under improved pharmacological technic, extensive clinical trial was given this drug, and since the onset of the present World War, it has been reported upon favorably from many different quarters. Its great advantage is, of course, the possibility of shortening the course of treatment.

The "multiple daily dose" method was worked out by O'Malley, a British Venereal Disease Department official of Capetown, South Africa. It is "especially suitable for that type of case where the most rapid form of therapy consistent with safety is desirable. *e.g.*, for seamen, personnel of the armed forces, and industrial workers, etc. in whom it is desirable to obtain rapid healing effects by an intensive scheme of treatment in order that they may resume duties at the earliest possible moment."

The patient must be physically sound except for syphilis (as proved by a thorough physical examination) and have no contraindications to arsenical therapy. He must be hospitalized and under constant competent supervision throughout the treatment period.

The method is as follows. Several times a day large doses of glucose solution (agreeably flavored) are orally administered, the first being given early in the morning, thereafter alternating with the mapharsen injections. Treatment is carried on for 5 to 7 days, depending upon the dosage and the individual tolerance.

On the first day, the patient is given

<i>By mouth</i>		<i>I V Injection</i>	
8 a.m.	$\frac{1}{2}$ oz. glucose in water	9 a.m.	0.02 Gm. mapharsen
11 a.m.	$\frac{1}{2}$ oz. glucose in water	12 noon	0.02 Gm. mapharsen
2 p.m.	$\frac{1}{2}$ oz. glucose in water	3 p.m.	0.02 Gm. mapharsen
5 p.m.	$\frac{1}{2}$ oz. glucose in water	6 p.m.	0.02 Gm. mapharsen

puncture while he lies in his own bed, and let him remain there, prone, without sitting up for any reason whatever, for 48 hours. This necessitates nursing care, for feeding, defecation etc., and cannot always be made absolute in a private home. But stress should be placed upon its necessity. If headache occurs despite all precautions it is likely to be severe and not alleviated by drugs. Lying quite flat and drinking a great deal of water will often serve to lessen its intensity.

### *Granuloma Inguinale*

Granuloma inguinale has a marked preference for the negro race and is more common in tropical and subtropical countries, though it is also endemic in the United States. It was first described in 1896 by the British physicians Conyers and Daniels, practicing in Guiana. Until comparatively recent years, the disease was believed to be confined to the tropics, but there is now not the slightest doubt that it has existed in certain sections of this country for fifty years or more but was not recognized as a clinical entity.

**Etiology and Bacteriology** The specific organism is the so-called "Donovan body," described by Donovan in 1905 and now generally accepted as pathogenic of the disease. This organism is a Gram negative, non motile, encapsulated bacillus of the *Bacillus mucosus capsulatus* (Friedlander) group.

The exact mode of infection is undetermined, but it is presumably transmitted through direct contact with an infected person.

**Pathology** The typical lesion is a bright red overgrowth of soft granulation tissue, with a slightly raised surface and a serpiginous border. It begins as a small papule, which soon ruptures, ulcerates and invades the surrounding tissue, showing no tendency to heal. The exudate at first is scanty, serous and inoffensive. It is easily wiped away and leaves a clean red, bleeding surface resembling the healthy granulation tissue of an extensive, clean surgical wound.

When secondary infection sets in the picture quickly changes. The lesions then emit a most offensive odor. Large lesions become bulbous, simulating condylomata acuminata with large round heads of new growth, the heads frequently having pearly white surfaces of epithelization and deep crypts with raw granulomatous surfaces.

The lesion affects the skin of the groin, perineum, vulva and prepuce. As the name implies it is most commonly found upon the groin, spreading both upward and downward and, in the male, usually extending to

the penis The preputial lesion presents a particularly destructive picture, gradually eroding the glans and extending to the shaft On the glans the lesion takes on a cauliflower like appearance, and in patients of cancer age may be mistaken for carcinoma The glans will be much distorted by the coarse granulations, which conceal the meatus and may even extend a short distance within the urethra When the lesion becomes annular, the formation of scar tissue may result in urethral stricture or partial priapism

**Symptoms and Diagnosis** The symptoms are purely local The granuloma is practically painless except under pressure, though there is often intense itching and burning More or less serous, and sometimes purulent, discharge is present

The long duration, the characteristic pathological changes, the marked resistance to all forms of therapy except antimony compounds intravenously administered, and the finding of the Donovan bodies in smears from the lesion are sufficient to establish the diagnosis Smears made from the exuding granulomatous surface will be found on staining (preferably by the Wright method) to be studded with the characteristic bacillus

**Differential Diagnosis** The condition is to be differentiated from chancroid, gumma, chancre, tuberculosis, and carcinoma Granuloma inguinale has little in common with these lesions, and the demonstration of the characteristic Donovan bodies ordinarily offers little difficulty, but it must not be forgotten that mixed infections may, and commonly do, exist

Granuloma inguinale differs from chancroid in its extent, painlessness, negative inguinal glands, absence of the Ducrey Unna bacillus in smears, and in its sclerosing, everted, rolled out edge as contrasted with the undermined edge of chancroid Its development is slower than that of primary or tertiary syphilis, from which it may be differentiated by dark field examination and negative Wassermann tests It differs from tuberculosis in its more rapid evolution, extent, and absence of caseation and tubercle bacilli As the granulations are more exuberant when the lesion involves the glans, it is here that it is most likely to be confused with carcinoma, and histological examination of a bit of excised tissue may be necessary

Any patient presenting a chronic sclerosing serpiginous ulceration of a granulous type, on or near the external genitals, should be thoroughly examined for evidence of granuloma inguinale

**Prognosis** The treatment of these lesions was most disappointing until the institution of the antimony therapy, the value and specific action of which were pointed out by Aragao and Vianna, of Rio de Janeiro, in 1912. With the proper use of the antimony compounds, however, the prognosis becomes extremely good, and complete cures can now be expected.

**Treatment** Among the various therapeutic methods which have been tried, with little or no success, are cauterization, curettage, fulguration, arsenic, excision, and roentgen ray.

The specific treatment, which seems now to be established on an unquestionable basis, is the intravenous administration of tartar emetic (antimony and potassium tartrate). The solution is prepared by dissolving 5 gm of antimony and potassium tartrate in 500 cc of distilled water, passing it through a Berkefeld filter until it is sterile on culture, and adding 0.5 cc of hydrochloric acid to prevent precipitation. A 1 per cent solution may be given intravenously in amounts as large as 20 cc without adverse reaction save in exceptional cases.

A good practice is to begin with 2 cc of the tartar emetic solution diluted with 8 cc of sterile distilled water, giving the injections intravenously 3 times a week. 1 cc more of the antimony solution and 1 cc less of the water being used at each treatment until the full strength (1 per cent) is given. The treatment usually covers 6 to 8 weeks, and it is wise to give a dozen or more weekly injections after complete healing has ensued, in order to prevent recurrence. Complicating secondary infections must first be cleared up before specific therapy will give its best results.

Fuadin, a trivalent antimony preparation, is less toxic than tartar emetic and is, therefore, preferred by many clinicians.

Compresses and irrigations of antimony-containing solution are valuable local measures.

### *Lymphogranuloma Venereum*

Lymphogranuloma venereum (lymphopathia venereum, lymphogranuloma inguinale) is a specific venereal disease due to an ultra-microscopic filterable virus and affecting chiefly the lymphatic tissues.

**Historical** Lymphogranuloma venereum has been recognized for over half a century as a clinical entity under the designations "climatic bubo," "non venereal bubo," "Nicolas Favre's" disease, and "lymphogranulomatosis inguinalis." A voluminous literature has accumulated

in regard to this disease under its various titles. A good historical survey is Hellerström's monograph (1929). The extensive literature has been thoroughly reviewed by Stannus (1933) in a monograph entitled *A Sixth Venereal Disease*, which contains 933 references. Good descriptions of the etiology, pathology, diagnosis, and treatment have been given by DeWolf and Van Cleve (1932) and Sulzberger and Wise (1932). Important observations upon the Frei test and the Frei antigen have been reported by Strauss and Howard (1934 and 1936), by W. H. Connor, Vigne and Bonnet, Prehn, and C. L. Wilmoth (all in 1937), and by A. W. Grace and his associates (1936, 1940, 1943). Stokes, Beerman, and Ingraham have published an excellent brief review of the subject as a whole.

**Age, Sex, and Race Incidence.** Neither sex nor race appears to influence the incidence or distribution of the disease. The disease at first was supposed to be peculiar to the male sex. It is now known that in women it follows a different course, with fewer occult manifestations. The primary lesion is usually on the cervix or posterior fornix, and the pathological process involves the intrapelvic much more frequently than the inguinal nodes (*Lymphogranuloma Venereum in Women*, p. 597). The primary lesion, being hidden, is usually overlooked and the disease is only suspected when, years later, sequelae appear as the result of scarring. Actually, the male incidence is probably not relatively higher than that of syphilis.

Although the disease is much more common in the negro race, this greater prevalence is probably due to sexual promiscuity and high rate of exposure rather than to any intrinsic susceptibility on the part of the negro individual (Stokes, *et al.*).

In general, lymphogranuloma venereum appears to be a disease found chiefly in adults in the period of active sexual life, most often in the third decade. Less than a dozen cases have been reported in children, who are accidentally infected by such conveyors of the virus as enema tips, bed-clothing, etc.

**Etiology.** The disease is due to a filterable virus. The virus is not easily destroyed by antiseptics but succumbs in 10 minutes to a temperature of 56°C., although it is unaffected by freezing temperatures for 1 day. It remains active after drying for 30 days, and may transmit the disease in dilutions as great as 1:10,000.

Gay-Prieto (1927) is credited with the earliest recognition of minute cytoplasmic granules in the cells of the inguinal bubo which later workers have shown actually represent the infective agent. They are uniformly

present in the lesions of lymphogranuloma venereum in man, in the experimental buboes of guinea pigs, and in the brains of infected mice and monkeys. The virus has been demonstrated by many workers to be present in all the recognized lesions of the disease (the primary genital lesions hypertrophic and stenotic inflammatory rectal lesions, and vulvar esthiomènes), as well as in the spinal fluid. Various studies indicate that the virus of the disease exists in human beings so long as the lesions are present.

The venereal origin of the disease, though long suspected, was finally proved by Phylactos in 1922.

**Pathology** A primary sore usually appears from 2 to 7 days after exposure. In the male, the initial sore is most commonly observed on the coronal sulcus, but may appear on the prepuce, glans, or in the urethra. In the female, the most common location is the posterior vaginal wall or posterior lip of the cervix, although it may occur anywhere on the external genitalia.

The inoculatory lesion may be herpetic, nodular, or papular. The most common form is a herpetiform vesicle, sometimes multiple, its clean cut edges surrounded by a bright red aureole. It is neither indurated nor infiltrated and, being painless, is likely to be overlooked by the patient. It heals spontaneously. Another type of primary lesion is a circular or oval papule 3 to 4 mm in diameter, having a slight indentation in the center from which serous exudate can usually be expressed. A third form is the small, hard nodule deep in the penile tissue, communicating with the surface by a fistulous tract which usually provides a channel for serous or serosanguineous fluid.

Sometimes the disease takes the form of a specific urethritis. If the lesion is situated within the urethra, its appearance will not be characteristic and greater difficulty in diagnosis will be experienced. Palpation usually reveals an indurated area, and when this area is viewed through the urethroscope there will be seen a considerable extent of infiltration containing in its center an ulcerous lesion with clear cut edges.

Mild systemic symptoms, such as headache, fever, and general malaise, may accompany the appearance of the primary lesion.

Ordinarily, in from 10 to 30 days after the appearance of the initial lesion, there is swelling and tenderness in the drainage area of the primary lesion, but swelling of the nodes may occasionally take place before the initial lesion is manifest. The incubation period for bubo may range as high as 7 or 8 weeks. The bubo is more frequently unilateral than bilat

eral In Prehn's series the average incubation period for bubo was 28 days, and unilateral involvement was seen four times as often as bilateral bubo. If the initial lesion is in the vagina or upon the cervix, direct extension of the infection through the rectovaginal septum leads to anorectal lymphogranuloma.

As the nodes enlarge, the overlying skin is at first reddened, but soon it takes on a deeper hue and becomes firmly adherent to the large mass of matted, swollen lymph nodes. As areas of softening appear in the underlying nodes, the skin breaks down at these points of suppuration to form multiple small fistulas. The entire area may be honeycombed with fistulous openings, discharging a thick, yellowish white purulent exudate in which no organisms can be demonstrated by the usual cultural methods. The histological picture shows a peculiar combination of infiltration and suppuration that is characteristic and not easily confused with any other adenopathy.

As the infection follows the lymph channels into the deeper tissue strata, the deeper iliac nodes become palpable, and even the lymphatics leading from the superficial to the deep nodes may be palpated as firm bands (Sulzberger and Wise). The adenopathy in the male, and in a small proportion of females, is usually localized in the inguinal or inguino-cruro-iliac group of nodes, giving rise to the syndrome long known as climatic bubo or lymphogranuloma inguinale (Stannus). In a greater proportion of women, and in a few men, localization in the intrapelvic nodes occurs.

After a variable period (2 months to 2 years usually) the glandular swelling subsides and healing takes place.

In neglected or improperly treated cases, permanent distortion from retraction and scarring occurs. In the male, elephantiasis of the penis, scrotum, or leg may result from widespread destruction of the glandular tissue and extensive extraglandular infiltration. Rectal strictures follow involvement of the perirectal lymphatics. Suppuration of the lumbar glands, extensive destruction of the psoas muscle, and extension of the infection to articular surfaces and to the kidney and adrenals of the involved side have all been observed (Stokes *et al*).

**Diagnosis** The inguinal adenopathy must be differentiated from chancroidal bubo, syphilitic and tuberculous adenitis, Hodgkin's disease, and malignant disease. Confusion with granuloma inguinale is unlikely. Mixed infections are common.

**The Frei Test** The diagnosis of lymphogranuloma venereum has

been greatly simplified by the Frei cutaneous test—the principal diagnostic resort at the present time. This test, devised by Wilhelm Frei in 1925, makes use of intracutaneous injections of the diluted and sterilized pus of proved, non ruptured, pure buboes of venereal lymphogranuloma. Frei's own directions for the preparation of the antigen are as follows. The person from whom the antigen is to be made should be proved free from tuberculosis and from any other venereal disease, past or present, that is, tests for syphilis, gonorrhea and chancroid must be negative and no clinical signs of these diseases present. Under aseptic precautions, pus (blood free so far as is possible) is aspirated from an unopened fluctuating bubo and mixed with normal saline solution in the proportion of 1 part of pus to 5 or 6 parts of saline solution, being sure that the mixing tube is sterile. This dilution is immediately put up in ampoules in amounts of from 0.5 to 1 cc., heated to 60°C in a water bath for 2 hours on the first day and for 1 hour the second day.

One tenth (0.1) cc. of antigen is injected intracutaneously on the palmar aspect of the forearm, or other convenient site. A corresponding point on the opposite side of the body is injected with normal saline only. The skin reaction should be read after 48 hours—no earlier. A positive reaction is evidenced by an inflammatory papule at least 0.5 cm. in diameter, often with peripheral erythema and sometimes with a central pustule. In negative cases, there is no reaction, or very little reaction after 2 days. On account of the possibility of generalized or focal reactions, it is not advisable to make the test in hyperacute stages of the disease or in cases in which suppuration occurs near the peritoneum.

The specificity of the Frei test for lymphogranuloma venereum is borne out by the latest reports. Connor and his co-workers (1937), reporting their experiences in 1,814 cases seen by members of the Medical Department of Western Reserve University, conclude that the test is specific for lymphogranuloma venereum and that only negative reactions are induced in syphilis and various other infectious diseases with which it might be confused. In Connor's series the Frei test was uniformly positive in all cases where the bubo had been in evidence for as long as 40 days.

A positive reaction does not prove that the disease still exists, because the power to react to the test remains in healed cases for many years. A positive reaction was obtained in one case 39 years after the original infection (Connor).

The time at which the Frei test may become positive varies consider



ably In some cases a positive reaction has been obtained as early as 10 days from the known onset of the disease, in others, more than a month has elapsed between the onset of symptoms and the obtaining of a positive Frei reaction Wilmoth found that in most instances the test is "weakly positive" in 15 days, increasing in its positive character as the disease progresses, usually becoming "strongly positive" by the twenty first day of the disease This author warns, however, that a positive Frei reaction does not prove that an existing adenitis or rectal inflammation is due to lymphogranuloma venereum If the patient gives a history of having had, even in the distant past, an inguinal swelling or a rectal inflammation, this would make the reaction positive, and in a patient of middle age it would be quite possible to overlook a carcinoma of the rectum or similar lesion on the strength of this positive reaction Thorough physical examination should never be omitted, no matter what the result of the Frei test

*Use of Standardized Lymphogranulomatous Mouse Brain Antigen for Frei Test* A recent and highly efficient modification of the Frei test is the substitution of standardized lymphogranulomatous mouse brain antigen in place of antigen prepared from human pus This modification which was first introduced in 1936 by Grace and Suskind, of the New York Hospital, is based upon earlier experimental work by Levaditi, Ravaut and Schoen Findlay, and Wassen The virus of lymphogranuloma inguinal was isolated by Grace and Suskind from the pus and glandular tissue of a patient with the inguinal type of the disease and successively transmitted in white mice by intracerebral inoculation They found that lymphogranulomatous mouse brains offer an excellent source of highly potent and specific Frei antigen, the potency increasing with successive passages This potency is retained for from one to two years after preparation These investigators claim that mouse brain antigen is not only as sensitive and specific as the most potent antigen prepared from human material, but it is without the disadvantages of the latter—namely, the scarcity of suitable human pus that is uncontaminated with other organisms, and the fact that specimens of pus taken from different human subjects vary in antigen content Standardized mouse brain antigen, on the other hand, is unlimited and readily available

The test is made by intradermal inoculation of 0.1 cc. of mouse brain antigen, and the results read at the end of 48 and 72 hours In subjects with lymphogranuloma inguinale, an erythematous papule, ranging

in diameter from 7 to 10 mm, is produced. The use of a control test with normal mouse brain antigen concurrently with lymphogranulomatous mouse brain antigen is advocated.

**Treatment** Spontaneous recovery after variable periods undoubtedly often occurs as is evidenced from the large number of positive Frei test reactions obtained in patients who no longer show any clinical signs of the disease.

No specific therapy, efficient under all conditions, has as yet been discovered. Prior to the introduction of the sulfonamide compounds, treatment consisted chiefly of injections of potassium antimony tartrate, fuadin, neostam and Frei antigen (by the interdermal and subcutaneous routes), all of which were generally ineffective. In early cases of inguinal adenitis, with involvement of only one or two nodes and slight periadenitis, local surgery and irradiation has sometimes been effective. Repeated aseptic aspiration of superficial nodes and irradiation of the deep nodes has also proved satisfactory.

At the present time, treatment is carried out mainly with the sulfonamide compounds, principally sulfathiazole. The sulfonamide drugs, properly administered, will cause the regression of lymphogranulomatous inguinal adenitis, suppurative and non suppurative, within a period of about 5 weeks, but long standing anorectal lesions, with stricture, require at least one year's therapy with rest periods of from 2 to 3 weeks after each course of treatment (Grace). For lymphogranulomatous inguinal adenitis the recommended dosage of sulfathiazole is 1.5 Gm three times daily for 2 weeks, followed at once by 1.0 Gm three times daily for 3 weeks.

Numerous authors have emphasized the striking symptomatic effects of treatment with the antimony compound lithium antimony thiomalate (anthiomaline), even in the anorectal involvements. The drug may be administered intravenously 2 or 3 times a week, beginning with an initial dose of 0.06 Gm and increasing by 0.03 Gm until the rheumatoid pains characteristic of antimony reaction appear. The dosage is then reduced until the pains are barely felt following an injection (usually to from 0.12 to 0.24 Gm). Twelve to 20 injections are given (2 to 4 Gm). After an interval of 2 to 3 weeks, patients are usually given a second course.

Shaffer has recently reported the results of anthiomaline therapy in 33 patients with lymphogranuloma venereum, and concludes that anthiomaline produces effects that are as satisfactory as those obtained with the sulfonamides, although the latter appear to be somewhat more rapid in their action. He believes that in some cases 'the alternate, or even

concomitant, use of both types of preparations might be efficacious when either alone might have failed." He advocates giving the drug intramuscularly in doses of 0.12 to 0.3 Gm. in aqueous solution, repeating the injections 2 to 3 times a week in courses of 2 to 4 Gm. until 12 to 20 injections have been given.

Late sequelae, such as rectal stenosis, urethral stricture, and elephantiasis of the penis and scrotum, are special surgical problems.

### *Herpes Progenitalis*

Herpes progenitalis is an affection common in both sexes, and takes the form of a group of follicles on an inflammatory base, which subsequently rupture and usually heal spontaneously in a short time.

**Etiology** It is probably due to irritation of a peripheral nerve or ganglion.

**Symptoms and Diagnosis** Herpes progenitalis generally occurs on the glans penis or prepuce in the male and on the labia in the female. A small group of vesicles on an inflammatory base first makes its appearance, accompanied by slight burning and itching. These soon rupture, leaving an area of superficial ulceration which generally clears up spontaneously in about a week's time. Sometimes, however, infection occurs, and there may be an accompanying enlargement of the inguinal glands.

The affection shows a tendency to recurrence, a tight prepuce and contact with irritating secretions acting as predisposing causes.

Though there is but little chance of confusing the lesion with venereal infections, the possibility of chancre should be ruled out by dark field examination, especially where there is glandular enlargement.

**Treatment** Healing is usually spontaneous. Strict attention to cleanliness, to prevent infection and the use of a mild antiseptic dusting powder after the vesicles break are all that is ordinarily necessary. If the prepuce is long, and there is a tendency to recurrence, circumcision may be advisable.

### *Tuberculosis of the Penis*

Primary tuberculosis of the penis is so rare as to be of slight clinical importance. Very little concerning it is to be found in the literature. In the early years of the present century considerable attention was given to this subject by French urologists, but in France, as elsewhere, it has remained a very uncommon lesion. Secondary involvement of the penis from a focus elsewhere in the body is also uncommon.

Tuberculosis of the penis may be superficial (lupus) or it may involve the cavernous tissue (tuberculous cavernositis)

**Etiology** Primary tuberculous lesions of the penile skin are exceedingly rare. They have been known to result from coitus with a woman suffering from genital tuberculosis (Warren) and to follow ritualistic circumcision by a tubercular *mohel*, who accomplished hemostasis by sucking the wound. Most of the latter cases have been in infants. The penis may be secondarily infected from foci in the kidney, prostate, seminal vesicles, or elsewhere in the body, and secondary lesions of the skin may follow an ulcerating tuberculous urethritis which has made its way to the surface.

**Pathology and Diagnosis** The tuberculous penile ulcer is superficial, irregular in shape, with everted edges and a greatly indurated base. The lesions are very intractable, spreading slowly and having a tendency to heal in one spot while extending to another. There may be swelling and suppuration of the inguinal glands. The general appearance of the ulcer is suggestive of malignancy, and differential diagnosis is therefore of great importance. There is also chance of confusion with gumma, but the tuberculous ulcer displays less tendency to slough, and except in the cases of circumcised infants, is of extremely slow growth.

Bacteriological examination will clarify the diagnosis.

Tuberculous cavernositis takes the form of hard nodules in the cavernous bodies and urethra which grow toward the surface, where they may ulcerate.

**Treatment.** As a rule radical excision of the diseased area and glands is the safest procedure. In those cases due to ritual circumcision treatment is practically never successful and the progress of the disease is rapid. Heliotherapy, roentgen radiation or fulguration may be successful in clearing up the local lesions.

### *Diphtheria of the Penis*

Primary infection of the penis with the Klebs-Loeffler bacillus is rare. Most of the reported cases have followed ritualistic circumcision. Penile lesions secondary to a focus elsewhere in the body are still rarer.

**Historical** The report of Hovne and Levy (1930) contains the first review of the literature to come to our attention. Fifteen cases were collected, to which the authors added one of their own. The first 3 reports were all made in the year 1897, recognition of the true nature of the lesion coming from widely separated parts of the United States. The diphtheritic infection followed closely upon ritualistic circumci-

sion save in one case, where a young adult displayed the characteristic manifestations of penile diphtheria at the same time his wife, child, and brother in law were suffering from the laryngeal form of the disease. In 1935 the literature was again reviewed by Borovsky, who gathered a total of 19 cases including his own. Sixteen of these were in children and 3 in adults. In the cases which did not supervene upon circumcision there had been some wound or inflammation of the penile mucosa which provided the necessary interruption of its continuity.

**Etiology** With our increased knowledge of the transmission of diphtheria, it is readily appreciable that an apparently healthy *mohel* might be a "carrier" of the Klebs Loeffler bacillus. That such may actually be the case would seem to be demonstrated by Borovsky's report, wherein 5 infants circumcised by the same *mohel*, developed penile diphtheria within the regular incubation time following the performance of the rite.

**Symptoms and Diagnosis** Suspicion of the diphtheroid nature of a lesion on the penis of a recently circumcised infant, or an adult whose penis has suffered some erosion or traumatic injury, should be aroused by a history of contact with a diphtheritic patient.

The lesion manifests itself as an edematous area, usually on or near the glans, which quickly becomes necrotic and sloughing. After 24 to 36 hours the characteristic thin gray film, such as is seen in the throat of the untreated diphtheritic subject, will cover the affected area. Previous to the appearance of this film the true nature of the infection will probably not be suspected, which is unfortunate inasmuch as the prompt administration of diphtheria antitoxin clears up the condition in a short time.

The diagnosis should be confirmed by culture of the organisms obtained by swabbing the affected area.

The usual precautions to avoid dissemination of the infection should, of course, be rigorously observed.

**Prognosis** As the condition is seen chiefly in very young infants, in whom resistance is at best low, the mortality is high, but when antitoxin is given promptly and courageously the chance of recovery is greatly improved.

**Treatment** The only treatment of any avail is the prompt administration of diphtheria antitoxin.

#### *Queyrat's Erythroplasia*

An unusual ulcerous condition seen upon the penis is Queyrat's ulcer (erythroplasia). Formerly regarded as benign, it is now recognized

as potentially malignant from its inception and should be treated as such

**Etiology** Its etiology is unknown but it apparently bears no relation to syphilis. Although a luetic history has been obtained in some cases in the majority the Wassermann reaction has been negative. Furthermore but a single case in a Negro has been reported (Irgang and Alexander) and as the incidence of syphilis is very high in the negro race this fact would seem to argue against a syphilitic origin for Queyrat's ulcer.

**Pathology** On the penis, it makes its appearance as a single or multiple clearly defined ulcer surrounded by an area of scaly angry looking dermatitis which may have been traumatized by scratching. The borders of the ulcers are usually neither undermined nor hardened although the amount of trauma to which the affected skin surface has been subjected has considerable influence upon the macroscopical appearance.

**Treatment** Treatment is complete eradication which has been successfully accomplished in early cases by means of the high frequency current. Roentgen therapy and surgical excision have not given as satisfactory results as has electrocoagulation.

### *Paget's Disease of the Glans Penis*

Though Paget's disease is customarily regarded as a lesion confined entirely to the nipple numerous extramammary cases have been recorded most of them involving the penis or scrotum. The disease is potentially malignant and may go unrecognized until cancer is present.

**Historical** Sir James Paget made the observations which eventuated in the disease being associated with his name in 1874. Probably the first extramammary case was that reported by H. Radcliffe Crocker to the London Pathological Society in 1889. Crocker's patient was a man of 60 years. A lesion somewhat eczematous in appearance but deeper and more sharply defined occupied the front and left side of the scrotum and the contiguous under surface of the penis. The picture presented was of an oozing superficially ulcerated easily bleeding surface with a well defined border and occasional pearly white islets. Two nodules were situated close together on the left side of the raphe. The ulcer had existed for about 6 months but the nodules had appeared only a short time before the patient came under observation. As the manifestations

strongly suggested those of Paget's disease, Crocker invited Sir James to examine the man. Paget declared that the lesion was of the same nature as those he had observed on the nipple. Histological examination of the nodules and affected skin, after surgical removal, showed carcinomatous degeneration.

A number of similar cases were collected in 1910 by Hartzell, of Philadelphia. In discussing these reports, Hartzell remarks that Paget himself was aware that the disease might manifest itself elsewhere than at the nipple, and had stated that he had seen such extramammary manifestation of the disease—a persistent rawness of the glans penis, resembling a prolonged balanitis, followed after more than a year by cancer of the substance of the glans. Hartzell also states that of the 18 extramammary cases he had been able to find 9 were upon the external genitals or close to them, and of these 5 were upon the glans penis.

Susman, in 1928, collected a total of 6 cases involving the penis and 3 upon the scrotum.

An interesting and more recent case (1931) involving the external genitals is that of Busman and Woodburne. The patient, a 46-year old Negro, had upon his glans penis what the authors describe as a typical lesion of Paget's disease—a small, infiltrated, sharply margined ulcer with an intensely red, finely granular, raw surface. There was no finely rolled border as in Bowen's disease, superficial epitheliomatosis, or other epithelioma. The lesion was too sharply margined and uniform throughout for an eczematous patch. Microscopically, the periphery of the lesion showed a characteristic picture of Paget's disease, while the center showed an area of squamous cell carcinoma. The writers regarded their case as being of especial interest in that it represented an intermediate step in the process whereby the condition designated as Paget's disease gradually alters to true carcinoma. They look upon Paget's disease as a clinical entity that is potentially malignant and serves as a precursor of a malignant state.

Susman, however, reporting an additional case in 1930, speaks of the striking similarity between Paget's disease and basal cell carcinoma, evidently regarding it as clinically malignant from the outset.

**Diagnosis.** The diagnosis is made by microscopic examination of tissue from the diseased area, which will show the characteristic Paget's cells if the disease is present.

**Treatment.** Treatment is the same as for carcinoma of the penis (p 303).

*Elephantiasis of the Penis*

Elephantiasis of the penis and scrotum is of two types (1) the true tropical form due to infection with *Filaria sanguinis hominis*

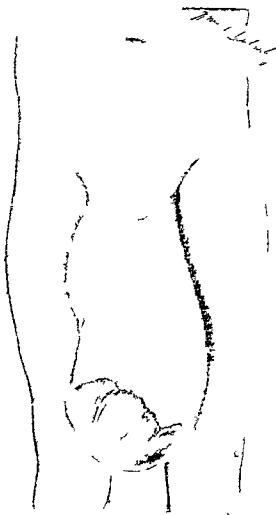


FIG 43 Elephantiasis of the penis and scrotum. (After model by Baretta. Collection of Pean Museum of Hôpital St Louis Paris)

(2) elephantiasis due to stasis of the penile and scrotal lymphatics from other causes such as syphilitic hyperplasia, trauma, lymphogranuloma venereum or other infections. In both the filarial and non filarial forms the lymphatic stasis results in imperfect absorption of inflammatory



products, stimulating hypertrophy and induration of the skin and subcutaneous tissues

Elephantiasis of the penis is seen only in conjunction with a like process in the scrotum (Fig 43) The scrotum may, however, be affected without involvement of the penis Watson reported a case in which the penis, though pressed upon by the huge scrotum, was entirely unaffected and coitus uninterfered with Frequently, both the scrotum and penis are involved, necessitating extensive plastic procedures, using skin from other parts of the body to cover the denudation occasioned by surgical removal of the hypertrophied tissues The skin of the penis, being less distensible than that of the scrotum, fissures more easily, so that the later stages of untreated elephantiasis upon the penis are regularly characterized by extensive sinuses discharging foul smelling pus

For an extended description of elephantiasis of the external genitals—both filarial and non filarial—the reader is referred to Elephantiasis of the Scrotum (p 424)

### *Gangrene of the Penis*

Gangrene of the penis and of the scrotum are discussed together in the section on Diseases of the Scrotum (p 419)

### *Plastic Induration of the Penis (Peyronie's Disease)*

Plastic induration of the penis is not a rare disease, although it often remains unrecognized until its later stages It is characterized by fibrous infiltration which begins in the septum between the corpora cavernosa in any part of the organ and later may extend into Buck's fascia and the tunica albuginea on each side in uneven plaques The asymmetric distribution of the fibrosis causes painful angulation or deformity of the erect penis, making coitus difficult or impossible

The disease was first described by de la Peyronie in 1743 Polkey found 549 undoubted cases in the literature in 1928, and many more have been added since

**Etiology** The etiology is unknown The lack of agreement regarding the cause is attested by the variety of terms used to describe the condition chronic cavernositis, circumscribed fibrosis, plastic induration of the penis, indurated cavernositis, plastic induration of the corpora cavernosa, and many others

Most of the earlier writers believed the condition to be either a fibrosis of inflammatory origin, or a general disease of the vascular system, often but not always of syphilitic origin

Sachs collected records of a large number of probable cases and from their examination concluded that venereal infection, and probably diabetes and gout, might be of etiological significance, and that trauma almost surely was.

Zur Verth and Scheele thought the induration arose from Buck's fascia and the adjacent area which is rich in elastic fibers. They believed that in older subjects the induration was a replacement of the elastic tissue by fibrous tissue such as takes place in the walls of the blood vessels during senescence, and that in younger men the degeneration of elastic tissue was due to the effects of repeated slight trauma undergone during coitus, chronic irritation, constitutional diathesis, or poisons (alcohol, tobacco). Rothschild also attributed the production of induration to the tension to which the penile sheaths are subjected during erection and coitus.

Wesson states that "internal trauma from prolonged ungratified sexual desires, or external trauma from lack of proper sexual cooperation are the direct causes. The approaching menopause with the concomitant frigidity of the consort is probably indirectly the principal cause of induration."

**Pathology** The induration appears as one or more plaques, or as a deep nodule, or a cord, of cartilaginous and even bony consistency. It originates, ordinarily, in the midline of the penis below the dorsal vessels, and involves Buck's fascia and the sheath of one or both corpora cavernosa, but rarely invades the spongy tissue. The indurated area may be quite thick, with very irregular outlines.

Microscopically, the scar like tissue resembles keloids, with but few blood vessels and many embryonic cells, from which develops the fibrous and osseous tissue. Small vessels appear to be embedded in connective tissue, and it is possible that the induration may originate in the sheaths of these smaller vessels.

True plastic indurations have no tendency to spontaneous disappearance. Suppuration, ulceration, and malignant degeneration of the fibrous tumors have not been reported.

**Symptoms and Diagnosis** The lesion occurs usually, but not always after middle life. Since the onset is insidious and development slow and for the most part painless, curvature of the penis on erection is likely to be the first sign to call the patient's attention to the disease. If pain does occur, it is usually during the initial stage, which may last for years. As the fibrotic process progresses, the induration becomes fixed and the deformity of the penis marked, making coitus impossible. Palpation in the later stages will reveal the bony lump.

Noticeable deformity in the flaccid state is uncommon, the deviation occurring only when the penis is erect. The degree and direction of the curvature depend on the location, form, and extent of the fibrosis. The angulation is most often upward and backward, less often laterally, and very rarely downward.

*Differential Diagnosis* Plastic induration is to be differentiated from the os penis described below and from syphilitic gummas, inflammatory and traumatic sclerosis, malignant tumors, and benign tumors such as fibroma, keloids, and chondroma, which are, however, very rare.

The absence of pain is the chief point in differential diagnosis. Lesions which might cause confusion, such as indurations of the urethral wall or of the corpus spongiosum, are so painful on manipulation that differentiation is relatively easy. Fibromas steadily increase in size, whereas plastic induration remains practically stationary for long periods, sometimes for years at a time. Malignant neoplasms are painless, but metastasis to the inguinal glands occurs so early that by the time the patient reaches the physician these glands are palpable. Syphilitic gummas seldom appear on the penis, and the Wassermann test or a history of antecedent syphilis will help in differentiation.

*Prognosis* The condition is a baffling one for both patient and physician. While treatment has undoubtedly benefited some, in other cases all attempts at cure have proved futile. The penile deformity in the later stages makes sexual relations impossible, and the psychic effect of this is far more distressing than the actual physical discomfort. All too often the surgeon's efforts to relieve the patient, if unsuccessful, merely serve to increase his resentment, and frankness from the outset is the wisest course. Since the condition at best is a difficult one to handle and the outlook for restoration of function poor, even the most optimistic operator should be guarded in making his prognosis.

*Treatment* Surgery, the success of which depends upon the plastic skill of the operator and the extent of the induration and the penile deformity, has proved curative in some cases. In early cases, in which the induration is limited to the septum between the corpora cavernosa, Lowsley has had successful results in 6 cases by the surgical removal of the indurated area, repairing the breaks in Buck's fascia with pads of fat (Operation for Peyronie's Disease, p. 358).

Röntgen and radium therapy have both been utilized without conspicuous success, although a few cures have been reported from the former. Electrolysis, diathermy, and other electrical treatments have proved of

no curative value. Injections of fibrolysin seem to have afforded improvement in some cases. Injections of autogenous vaccine made from the tissues when the condition follows granuloma inguinale, has been successfully utilized by Jose May of Montevideo. The fact that the fibrotic process often remains stationary for long periods makes it difficult to tell just how much permanent improvement has been effected by any non surgical treatment.

### *Bone Formation in the Penis (Os Penis)*

**Etiology** Os penis is found—regularly or exceptionally—in certain mammals including the Primates but is not a natural condition in man in whom the penis normally consists entirely of soft tissue. Pathologically formations resembling bone are found in the human penis though the condition is rare. Various explanations of this phenomenon have been offered some investigators claiming that the osseous structure is an acquired calcification and others an atavistic reversion.

Jacobi in 1924 wrote of a so called fascia bone observed in the tunica albuginea. Its origin is from calcareous deposits laid down between the fibers of the tunica fusion of the scattered deposits forming a structure *resembling* bone in that it contains haversian canals and lamellae but plainly not bone because no osteoblasts or osteoclasts are demonstrable.

Ruth reviewing the available data in 1934 concluded that while the os penis of the lower orders of animals is osteoblastic and periosteal in origin and assumes a definite form and size for each species in the human penis any such development must be considered abnormal being a progressive development of a fibro metaplastic nature and never a prenatal growth or a normal developmental process of early life.

**Symptoms and Diagnosis** Pain on erection and difficult coitus or inability to copulate are the chief complaints.

Os penis is to be differentiated from the chronic fibrosis (Peyronie's disease) described above and from fibrotic changes due to trauma or syphilis.

### *Benign Tumors*

#### CONDYLOMA ACUMINATA

Condylomata acuminata (venereal warts verrucae papillomas) are wart like excrescences on the skin of the external genitals. They occur most commonly on the coronary sulcus or posterior edge of the glans less often upon the inner margin and surface of the prepuce and occa-

sionally at the meatus or near the frenum. They are most frequent in the early years of sexual activity, but may occur at any age.

**Etiology** Condylomata acuminata arise from an undue proliferation of both epithelium and connective tissue, are papillary in type and usually highly vascular. The adjective 'venereal' is distinctly misleading, for though these growths are commonly found in those who have had gonorrhea or syphilis their primary cause is irritation of the skin or mucous membrane by prolonged contact with inflammatory exudates. Phimosis, a redundant prepuce and uncleanness are predisposing factors. Congenital predisposition may also play some part.

Though there are records of these warts being experimentally produced in animals by inoculation, proof that they are contagious is still wanting. Wile and Kingery found that a sterile filtrate of wart material injected subcutaneously produced localized hyperkeratosis clinically and pathologically identical with verruca vulgaris. This led them to believe that interpapillary hypertrophy, inflammation, and marked keratosis occur as secondary traumatic manifestations, and while such localized keratosis may be due to trauma or the presence of foreign bodies, it is not improbable that these merely act as inciting factors providing a portal of entry for the infective agent.

**Pathology** Condylomata acuminata may be single, multiple, or conglomerate. They assume various shapes according to their location, sometimes appearing in raspberry or 'cauliflower' shape and again as mere threads. In certain locations as beneath the prepuce and on the glans the pressure of the surrounding structures may reduce them to flat plaque like shapes. They are usually moist and attended by an irritating and offensive serous or mucoid discharge.

**Treatment** Ordinarily excision or fulguration is necessary. Cleanliness, keeping the area dry, and removal of the cause of the irritation are important to prevent recurrence. If there is phimosis or a redundant prepuce, circumcision should be done. Occasionally lesions disappear with cleanliness and the use of an antiseptic dusting powder. When allowed to remain filthy and untreated, ulceration and suppuration eventually take place, and it is probable that the area thus affected will be predisposed to malignancy.

#### CONDYLOMA LATA

Condyloma lata is the broad moist papular wart of secondary syphilis. It occurs about the external genitals and anus. The growths frequently coalesce and extend over a considerable area.

**Diagnosis** Since differentiation between the two types of condylo-

loma of unknown origin which may, according to Ewing, become actively malignant in its later stages if the conditions are favorable. The disease seems to be prevalent only in southern Europe, the cases seen in this country being regularly in immigrants from that part of the world.

**Pathology** The characteristic lesion begins with an inflammatory spot, which becomes edematous and cyanotic and later develops into a flat infiltration or nodule. These nodules are often of a blue color, due to hemorrhage. They become painful, the inflammation increases, and deep ulceration is not uncommon as a later manifestation, although at the outset the lesion is distinctly one of the skin surface.

The common site for the initial lesion is the thigh, appearance on the penis being distinctly unusual. Barringer and Dean have reported 2 cases recently, and a few others are on record.

**Prognosis and Treatment** It is now commonly accepted that though this condition is at first infectious in nature, probably due to a specific agent as yet undiscovered, in advanced lesions we have to deal with a spindle cell sarcoma which offers the same grave prognosis and requires the same treatment as any other penile sarcoma.

#### CARCINOMA

Carcinoma usually epithelial is a relatively common neoplasm upon the penis, and is estimated as constituting about 2 to 5 per cent of all cancers of the skin in men. Early in the history of medicine we find descriptions of the lesion and of attempts to extirpate it, and the literature available upon the subject is extensive.

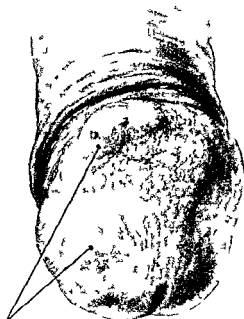
**Etiology** The etiology, as in other forms of carcinoma, is obscure.

*Phimosis* is undoubtedly an important predisposing factor. In India, a marked difference in incidence of penile carcinoma is found between Hindus, who do not practice circumcision, and Mohammedans, who practice it as a religious rite, and in whom carcinoma of the penis is practically never seen. Of 792 cases of cancer occurring in a certain section of India, more than 10 per cent were carcinomas of the penis, all of which occurred in Hindus (Sutherland). In 100 cases reported by Barney in 1907 and in 36 reported by Barringer and Dean in 1923, not a single circumcised Jew was found. Numerous other writers have called attention to the apparent immunity of the Jews from this disease, which suggests that early circumcision undoubtedly has some influence against its development. When, as the result of a prepuce difficult or impossible to retract, there is added the irritation of retained inspissated smegma, the circumstances are ideal for the development of penile cancer.

*Trauma* probably accounts for a certain percentage of cases

*Syphilis* is probably an etiological factor in some cases, and instances of cancer of the penis developing on the site of a healed or imperfectly healed chancre have been noted by many writers. Venereal warts may sometimes be the forerunners of cancer, and many agree that all papillary growths on the glans penis are potentially malignant. Paget's disease and Quevrat's ulcer may be precursors

Wm P Didusch  
1930



carcinoma

FIG 44 Carcinoma of the glans penis Early case

**Pathology** The majority of penile carcinomas arise upon the glans or in the coronal sulcus

The tumor begins as a wart like excrescence or as an ulcer, which, in the presence of phimosis may be overlooked until the disease has infiltrated to a considerable extent. The neoplasm may be of either the papillary cauliflower like type, more likely to be found on the glans, or the infiltrating indurated ulcer type, which is commonly located in the corona. The ulcerating type progresses more slowly than the exuberant type, but both soon display metastasis to the inguinal nodes

Histologically carcinoma of the penis is almost exclusively a squamous cell variety

The chance of arresting malignancy of the penis is greatly lessened if metastasis to the inguinal nodes has occurred by the time the patient comes under treatment. The majority of these affected nodes break down and become secondarily infected and death frequently results

Wm P Didusch  
1930

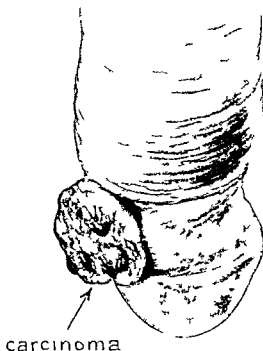


FIG 45 Carcinoma of the penis papillary type

from the effects of this secondary infection rather than of the primary malignancy. Death by hemorrhage due to sloughing of the wall of an important blood vessel usually the femoral artery has occurred.

**Diagnosis** Early diagnosis is of the greatest importance. Difficulty may be experienced in differentiating between benign condylomata acuminata and the papillary cauliflower like form of carcinoma. Whenever



there is doubt, a biopsy should be performed and the diagnosis confirmed by microscopic examination before radical surgery is resorted to. A dark-field examination may be necessary to rule out chancre in some cases of early epithelioma.

**Prognosis.** The prognosis depends on the stage at which the lesion comes under treatment. Lesions that have infiltrated the cavernous tissues usually require partial or complete amputation of the penis.

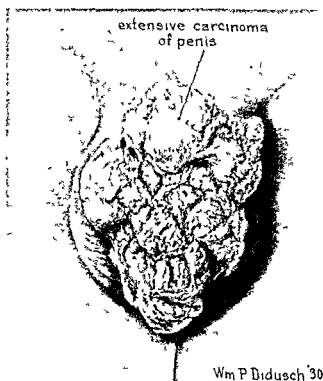


FIG 46. Extensive carcinoma of the penis, papillary cauliflower like type

**Treatment.** Urological opinion is divided as to the best method of managing carcinoma of the penis. The primary tumor may be treated by (1) partial or complete amputation of the penis, with transplantation of the urethra into the perineum in the latter case (p 323), (2) excision of the superficial portion of the tumor by cautery or high-frequency current (p 333), followed by implantation of radon seeds in the base; (3) irradiation alone. Most urologists and radiotherapists prefer to remove the metastatic inguinal nodes by surgery. The irradiation of penile carcinoma, and the respective merits of surgery and radium, are

discussed under Radium and Roentgen Ray Therapy of the Genito-Urinary Tract (p 1734)

Wm P Didusch 1930

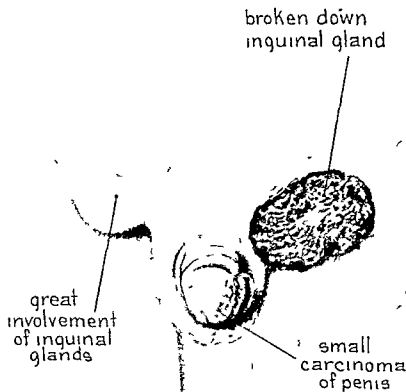


FIG 47 Small carcinoma of the penis with great involvement of the inguinal glands. The left group of glands has broken down and presents a fungus like growth in the groin.

#### LYMPHOGRANULOMATOSIS (HODGKIN'S DISEASE) OF THE PENIS

The characteristic dermal lesions of lymphogranulomatosis (Hodgkin's disease) have been reported at least once as having been observed upon the penis (Sharlit) and have doubtless been seen by others but have gone unrecognized. The condition is undoubtedly extremely rare, and is mentioned merely to encourage reports by others, to the end that the recognition of the condition in clinical practice may be facilitated.

**Etiology** As with most malignant conditions, the precise etiology of Hodgkin's disease is unknown.

**Pathology and Symptoms** Its initial manifestation is usually the enlargement of a chain of lymph nodes, so that when the penis is the site of the invasion the inguinal nodes become palpable. In most cases of Hodgkin's disease there is also a skin eruption resembling eczema and usually mistaken for it. At about the same time enlargement of the liver and spleen may be determined on palpation. In practice however, patients seldom come under observation until the condition is far advanced. Secondary anemia regularly supervenes and may be so evident as to center attention upon this feature and delay the recognition of the lymphogranulomatosis.

In the case reported, the penile lesion took the form of a patchy exfoliation upon the mucous lining of the prepuce.

**Diagnosis** If clinical evidence of Hodgkin's disease elsewhere in the body is revealed by such an examination, the diagnosis of the penile lesion will be comparatively simple, otherwise, the nature of the lesion may be recognized only after microscopic examination of an excised lymph node.

**Prognosis and Treatment** The prognosis of Hodgkin's disease is uniformly poor, and the treatment unsatisfactory. Life has been prolonged by the use of physiotherapeutic agents. Deep x ray therapy seems to have given the most encouraging results and should be tried in suitable cases.

### *Priapism*

True priapism is prolonged and persistent erection of the penis unaccompanied by sexual desire. It is usually, but not invariably, painful, relatively infrequent, and is to be distinguished from the transitory and recurrent nocturnal erections which are common in inflammatory conditions of the urogenital tract and in certain nervous affections. Transitory priapism usually subsides with improvement in the local condition, though that of nervous origin is sometimes highly resistant to treatment and may recur for years. True priapism on the other hand, does not respond to medication and subsides spontaneously, usually very gradually.

A lengthy study of priapism in all its aspects was published by Oscar Scheuer in 1911, and in 1914 Hinman collected 170 cases from the literature and added 2 of his own. Since then, numerous additional cases have been reported, but little that is new has been added to our knowledge of the etiology and pathology.

**Etiology.** The mechanism upon which erection of the penis depends is a complex phenomenon of combined nervous, circulatory, and muscular factors. A variety of conditions may alter their normal functioning in such a way as to produce priapism.

Priapism may be either *nervous* or *mechanical*, or a combination of both. There are a number of nerve lesions and conditions of nervous imbalance which may produce this painful condition. Among the local mechanical causes may be mentioned thrombosis, hemorrhage and hematuria, tumors encroaching on the nerve-endings, inflammatory swellings and edema. Sometimes no cause can be found and the physician is compelled to fall back on the term "idiopathic." Leukemia is now believed to be the cause of many of these so called idiopathic cases.

Priapism may be due to *local* causes, such as trauma and external irritations, or it may depend upon a general *systemic* condition, such as syphilis and leukemia. Local causes are, as a rule, mechanical in nature, while systemic causes are more likely to be of nervous influence. The mechanical cases are greatly in the majority, for in most instances where operation has been undertaken thrombosis of the blood vessels, or other cause of venous congestion and obstruction, has been found. The fact that in many instances the corpora cavernosa alone were involved would favor the theory of venous thrombosis as a leading cause of pathological erections.

Priapism then cannot be regarded as a disease *per se*. It is, rather, a symptom of some underlying pathological state, although frequently it has proved impossible to postulate the underlying cause.

*Priapism Due to Neoplastic Growths.* Although the earlier literature on priapism mentions the possibility of persistent non-erotic erection being due to neoplastic growths, their occurrence would seem to be clinically most unusual. Of the 170 cases of priapism collected by Hinman none was due to this etiological factor. Several cases have been reported in recent literature, however, so that this possibility should be kept in mind by any physician faced with the management of this perplexing problem.

In Frontz and Alyea's case the patient had previously undergone cystoscopy during investigation of a painless hematuria. Immediately following the instrumentation the penis became erect and persisted in a state of painful semi-erection for 4 months. Under a diagnosis of instrumental trauma both corpora were incised and thick, grumous black blood expressed. Necrosis of the operative incision setting in on the

fourth day, amputation of the corpora was done, but the patient died 17 days after operation. At autopsy, it was found that each corpus was represented by two solid cylindrical tumor masses which had completely replaced the spongy tissue. Extensive metastases were scattered throughout the body. No suspicion of malignancy had been entertained during life.

A somewhat similar case—of sarcoma in a child—was reported by Cowie in 1920.

*Leukemic Priapism* That priapism sometimes occurs in patients suffering from leukemia is an observation that has been recorded at scattered intervals in medical publications for the past half century. The definite connection was not established, however, until the last decade.

There is nothing characteristic about the persistent erection seen in the leukemic patient. If the blood condition is not suspected the case will doubtless be classed as of nervous origin. It should however, be grouped with those of mechanical cause. As priapism is seen only in leukemia of the myelogenous type, the mechanism is probably that of thrombosis, by reason of an excess of myelocytes crowding the corpora cavernosa. Achard (1930) found records of about 50 cases in literature wherein priapism was the first sign of the myelogenous leukemia, and examination of the blood revealed the true state of affairs.

Leukemic priapism yields to treatment by puncture or incision in the same degree as when the persistent erection is dependent upon other mechanical causes. Treatment of the blood condition is, of course indicated, but we have found no reports of recurrent priapism due to inability to check the increase of myelocytes in the blood stream. Blood examination should be made at once in any case of priapism the reason for which is not quickly apparent.

*Symptoms and Diagnosis* Though priapism may occur in infants and in aged men as a rule it is seen in adults in the full vigor of life. Hinman's series included a newborn infant, the cause of the priapism being congenital syphilis. His oldest patient was 75 years.

Most patients have more or less pain, which may sometimes be intense. Urinary symptoms vary, but there is likely to be frequency and difficulty of urination. There may also be complete retention, necessitating catheterization, which may have to be done under anesthesia. In most cases of true priapism, particularly where the cause is mechanical, erection is confined to the corpora cavernosa. In transitory erections, the entire

organ is usually involved. Perhaps the chief symptom is the mental anguish these patients undergo.

It is important for purposes of treatment that the underlying cause be determined. This is frequently difficult and sometimes impossible. The history should be of assistance, the factor of nervous influence being often exhibited only in this way. Trauma, even if it be very slight, may have set up thrombosis, and efforts should therefore be made to elicit any history of accidental injury. Palpation will sometimes reveal the presence of a hematoma. If there have been previous transitory erections, the inference is that some mechanical factor is at work. In any event complete examination of the urogenital tract is imperative for even if a definite mechanical cause is established, it may be dependent upon an inflammatory focus.

If nothing is found amiss in the urogenital tract, a neurological investigation may be indicated. Spinal-cord lesions sometimes are first manifested by persistent erection. Serological tests should be performed and syphilis of the brain or spinal cord ruled out before any radical treatment is undertaken. The blood should also be examined for evidence of leukemia. Several authors have connected priapism with the existence of nasal polyp and in view of the similarity of the tissue structure of the nose and the penis and the generally accepted relationship between the nervous mechanisms of these two structures such a theory is not unreasonable. Scientific proof, however, is still lacking.

**Prognosis.** The prognosis is good. When the erection does not subside spontaneously or under the persuasions of local treatment, incision or aspiration of the corpora is regularly followed by collapse of the erection. Transitory erections due to mechanical causes subside with removal of the irritative stimulus. Chronic recurrent erections due to psychic causes are frequently very stubborn.

**Treatment.** The treatment varies and is dependent upon the etiology. Some patients get well spontaneously. If the underlying cause is known treatment is of course directed toward its removal. Transitory or persistent erections dependent upon a focus of irritation in the urogenital tract usually subside with improvement in the local condition. Nervous priapism should have thorough general treatment before operation is resorted to. If the cause be a disturbance in innervation theoretically at least, division of the involved nerves might dispose of the erection. We have never done this, however, nor do we know of anyone who has.

If the underlying cause cannot be determined or if—as in some diseases

of the central nervous system—no other means of relief are available, operative measures may be tried. Incision of one or both of the corpora cavernosa, with expression of thrombosed blood, has proved most effective in our hands in the few cases where surgical interference became imperative. The incision should be carried well into the spongy tissue, carefully avoiding the artery traversing each corpus and adequate drainage should be provided when the wound is closed. Grumous blood should be removed, and if there is any suspicion of malignancy the removed material should be subjected to microscopic examination. Incision of the corpora is the simplest and most effective form of treatment of mechanical priapism irrespective of its etiology. It is usually followed by prompt relief and does not destroy the power of erection. Recurrence of priapism may, however, take place, requiring repetition of the operation.

Aspiration of the engorged corpora, instead of incision, is sometimes done.

### *Preputial Calculi*

Primary preputial calculi are relatively uncommon (90 cases up to 1935, Ingraham), and form only in the presence of an abnormally tight prepuce. They are probably encountered even less frequently today than in the past, owing to the greater appreciation of the dangers of phimosis and the more frequent performance of circumcision.

A case of preputial stone was discovered by Lowsley in 1917 in a man who was being examined for the draft during the World War, and the stones successfully removed.

**Etiology.** Stagnation of urine, plus phimosis is probably the chief etiological factor in the formation of these stones. Solidified smegma may be the basis of some. The extreme narrowness of the preputial opening permits the stones to form, and the pressure induced by retardation of urine stretches the preputial sac, allowing the depositing and retention of urinary salts and smegma, so that a vicious circle is set up which can be interrupted only by excision of the tight prepuce.

**Pathology.** In perusing the literature, one is astonished to find that as many as 2 000 small stones have been removed from such a sac. F. D. Thomas (1930) regarded his 208 as a record, being evidently unaware of Ingraham's report, less than a year earlier, of the removal of 1,072 from a 30 year old Negro of Philadelphia. As the concretions are palpable as soon as they attain any appreciable size, and are so located that the patient must feel them every time he urinates, it is difficult to

understand how even the most unintelligent individual could permit the formation of a mass of such unbelievable size before seeking relief

Severe damage from retention and back pressure sometimes results before the urinary difficulties compel the patient to seek relief. Single stones as large as a hen's egg, and quite capable of inducing pressure necrosis, have been reported. Dilatation of the anterior urethra and trabeculation of the bladder mucosa not infrequently result, and in protracted cases there may be hydro ureter. Infection of the entire urinary tract has occasionally been encountered, even the kidneys suffering from the ascending infection. Traumatization of the surrounding tissues by the stones may cause a malignant growth at least one such instance having been reported.

**Diagnosis.** The diagnosis is generally made without difficulty, as the gritty feel of the concretions indicates at once the true nature of the mass. Confusion with an extraneous body may be possible, but as circumcision is in any event the only remedy, determination of the precise nature of the mass before removal is not of great importance. Occasionally, however, there may be difficulty in differentiating it from carcinoma of the glans.

**Treatment.** Circumcision, and removal of the stones, affords immediate relief but will not, of course, halt an extensive infection or a malignant growth already initiated.

### *Impotence*

Impotence signifies inability of the male properly to perform the sexual act. It may vary in degree from premature ejaculation of the seminal fluid to complete absence of erection. The mechanism of copulation requires a complex coordination of the nervous, vascular and muscular systems. This has been described in the section on Physiology (p. 241).

**Etiology.** Impotence may be organic or functional.

*Organic impotence* may be due to a variety of causes. Coitus may be rendered mechanically impossible by some physical deformity, either congenital or acquired, such as pronounced hypospadias or epispadias with a small or deformed penis, plastic, syphilitic, or traumatic induration of the penis, absent concealed, or rudimentary penis, traumatic or inflammatory lesions of the perineum, resulting in extensive scar tissue elephantiasis of the genitals, tumors, hydrocele, varicocele, marked phimosis, and hernial swellings. It may be dependent upon certain pathological changes in the urethra or its adnexa, such as verumontanitis,



posterior urethritis, polyps, or irritative conditions due to masturbation, coitus interruptus, or excessive intercourse. It may also be due to organic disease of the nervous system, general paresis, endocrine deficiencies, lack of tone of the penile muscles, or old age. A temporary organic impotence may result from excessive use of alcohol, tobacco, or drugs.

*In functional impotence* the loss of potency is due not to lesion of the genitalia, urethra, or nervous system, but to neurotic and psychoneurotic factors. Sometimes it is merely an attitude of mind. It may arise from nervous excitement, timidity, lack of confidence, indifference toward the sexual partner, or sexual perversion. It may be due to excessive sexual excitation or to a general neurasthenia caused by severe and prolonged mental strain, the impotence being but one symptom. Sexual disturbances are both the cause and effect of mental disturbance, resulting in a vicious circle that presents a perplexing and difficult problem.

**Diagnosis** It is important for purposes of treatment to differentiate between the types of impotence and to ascertain, if possible, the exact cause of the condition. Impotence, being a symptom of some condition that may be either physical or psychical, frequently requires complete physical and psychical examination in order to determine the cause. The history, including an account of the sexual habits, the usual physical examination of the external genitalia and rectum, and examination of the urine will ordinarily serve to indicate whether the impotence is dependent upon organic or psychical factors. Urethroscopy will reveal any lesions of the verumontanum and posterior urethra.

**Prognosis** The curable cases are largely psychical. There are certain persons, however, whose impotence is due to traumatism, over-stretched muscles or other organic factors, who are relieved in a great many cases by the plastic operation of Lowsley. These cases must be skilfully selected and handled. The prognosis is bad, and treatment of little use, when the impotence is dependent upon organic cerebrospinal lesions.

**Treatment** Treatment may be divided into *general* and *local*. General measures are chiefly medical and psychotherapeutic, local measures, primarily surgical.

Where the impotence is dependent upon some organic lesion of the genitalia or urethra, treatment is local, and consists in correction, so far as possible, of the deformity, infection, drug habit, alcoholism, or other condition causing it.

The use of gonadotropic hormones in the treatment of impotence is still in its infancy, but studies to date indicate the hopeful possibilities of this new field. For a number of years we have been using subcutaneous injections of an especially prepared alcohol extract of gonads, adrenal and pituitary, in an attempt to boost the internal secretions of the patient—with many favorable responses.

In certain cases of organic impotence, such as those due to traumatic or inflammatory lesions of the perineum, lack of muscle tone, or advancing age, we have had considerable success with the plastic operation recommended by Lowsley and described on page 350.

Impotence due to a purely functional neurosis, and not to disease or deformity, is a neurological rather than a urological problem. The psychic cause should be ascertained, erroneous impressions corrected, and the patient's fears removed and his confidence restored if possible. The general health should be built up. Sexual intercourse, and anything—physical or mental—that stimulates the sexual appetite, should be interdicted so as to give the exhausted nerve centers a chance to renew themselves. The use of diathermy and hydrotherapy is advised by some, but whether these are actually beneficial of themselves or merely help to change the patient's psychic outlook, is problematical.

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## CHAPTER IX

### OPERATIVE TREATMENT OF THE PENIS

Operations upon the penis, though not numerous in type, include some of the most important of genito urinary procedures. Circumcision a relatively trivial procedure, has, nevertheless, such far reaching influence upon the sexual and urinary history of the male that it may properly be ranked as a major operation. Amputation of the penis, entailing impotence and extended psychic as well as physical effects is an intervention undertaken only under the most compelling circumstances. Between these two, and comprising the majority of penile operations are the plastic procedures for the repair of penile injuries and for the correction of such distressing conditions as epispadias, hypospadias, and impotence. These require the utmost in surgical ingenuity and skill.

#### *Anesthesia*

Most surgery upon the penis is carried out under local or regional anesthesia. In the majority of urological clinics the use of a general anesthetic even for the more extensive procedures, is becoming increasingly less common. It has been found that practically all surgery upon this organ can be satisfactorily performed under local infiltration anesthesia (using novocaine, 1 per cent), spinal, or sacral anesthesia. Intravenous anesthesia, with pentothal sodium is very satisfactory for a short minor procedure. For children, general anesthesia is preferable, both for circumcision and for the lengthier plastic procedures for hypospadias and epispadias.

The various methods are discussed in the chapter on Anesthesia in Urology (p 190)

#### *Preparation of Operative Field*

We have found a 10 per cent solution of tincture of merthiolate and tincture of zephiran, to be excellent skin antiseptics. The area is first thoroughly cleansed with green soap and water, followed by sponging with alcohol, 70 per cent. The merthiolate or zephiran is then applied



*Circumcision*

**Anesthesia** A light general anesthetic is usually preferable for children. For adults, some surgeons prefer nerve block, but we feel that the ordinary infiltration anesthesia is sufficient for this procedure.

**Sterilization of the Field** The area is washed with green soap and water and the skin disinfected by the usual method, retracting the prepuce as much as possible so as to cleanse the underlying portions of the glans. If the prepuce is so tight that this is impossible, cleansing may sometimes be accomplished by injecting irrigating fluid beneath the prepuce.

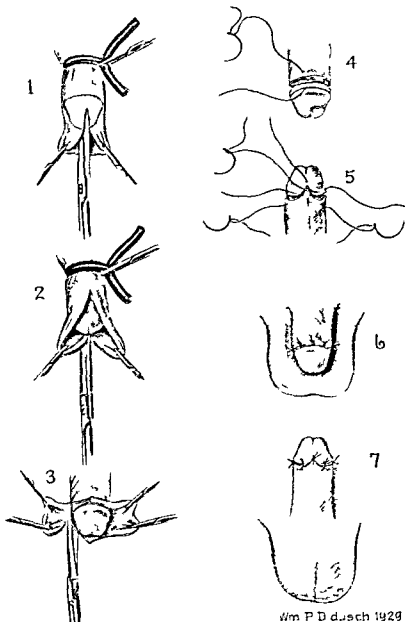
**Technic of Circumcision** The following is the method of circumcision used in the authors' clinic, the technic being varied in some of its details according to the judgment of the operator.

After the usual surgical cleansing and anesthetization, a clamp or tourniquet is placed about the base of the penis to control excessive bleeding. Under suitable aseptic precautions, the prepuce is retracted until the preputial orifice is tensely stretched. The tip of the prepuce is grasped with two or three Allis clamps, and a grooved director inserted between the prepuce and the glans penis. With a pair of sharp scissors, a median incision is made from the point of insertion of the director downward to about 1 cm. from the coronary sulcus. Cutting at right angles from this initial incision, the prepuce is excised except on the posterior surface where a V shaped section is retained. The constriction at the base of the penis is now loosened and clamps applied to any bleeding vessels with plain catgut ligatures if necessary.

Kirwin avoids cutting through the frenum. Lowsley, on the other hand, severs the frenum but reconstructs it with great care, usually employing three sutures. Both operators approximate the edges of the wound very completely with plain catgut, Lowsley placing one suture at the tip of the V shaped section of the prepuce left on the under surface (which is carried through the frenum's tip and is not removed) and a second and third suture on either side (Fig. 48).

**Dressings** Though many surgeons do not dress a circumcision wound, with the exception of anointing the suture line with sterile vaseline, we prefer a sterile gauze dressing.

For his adult patients, Kirwin utilizes a bandage of sterile vaseline gauze which is placed about the shaft of the penis and held in place by strips of adhesive (Fig. 49). Sometimes an antiseptic ointment con-



Wm P D Busch 1929

FIG 48 Circumcision (Lowsley's method) (1) Dorsal slit. (2) Incising the frenum with accompanying prepuce (3) Excising the excess prepuce leaving a cuff of tissue at the sulcus (4) Applying the dorsal suture (5) Reconstructing the frenum. (6) Suture of the cut edges completed dorsal view (7) Ventral view

taining yellow iodide of mercury (2 per cent) is used. The patient is provided with a glass tube and instructed how to pass his urine through

the tube so that none will come in contact with the adhesive plaster. The dressing is thus kept dry, and, whenever possible, is left in place

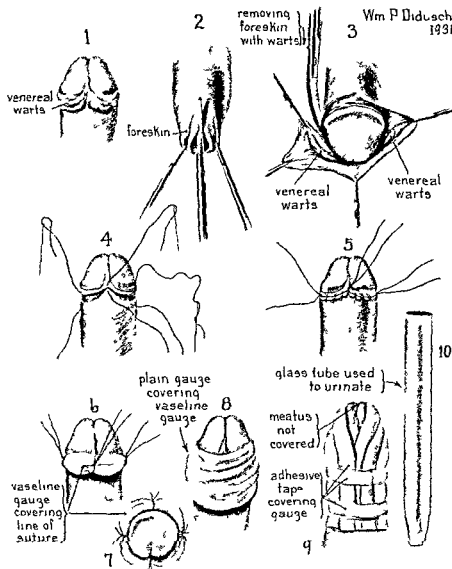


FIG 49 Circumcision (Kirwin's method) or operation for removal of venereal warts (1) Venereal warts along the under surface of the frenum (2) Dorsal slit (3) Excising the excess prepuce (with the warts in this case) (4) Inserting stay sutures which are left long to hold the vaseline gauze in place (5) Suture of cut edges completed (6 to 9) The ends of the sutures are tied around the vaseline gauze which is covered by additional gauze held in place by adhesive tape (10) Glass tube through which the patient voids to prevent soiling the dressing

until healing is complete—usually 6 or 7 days. This method cannot, of course, be followed with infants, but is recommended when the patient

is able to cooperate, as it practically insures the wound against infection if the dressing is properly adjusted in the first place

In very young babies, where the cut surface is in constant contact with the wet napkin, the practice of using no sutures whatever, but merely applying sterile vaseline to the line of excision, is undoubtedly the best method. If sutures are used, sterile gauze may be laid over the suture line to keep it from contact with the clothing. Proper hemostasis will usually prevent hemorrhage and hematoma formation. Occasionally a young child may prove to be a "bleeder." In these circumstances it may be difficult to effect proper hemostasis and a hematoma may form between the skin and mucous membrane of the sutured margin of sufficient size to break down the stitches. This complication though rare, is of serious import when it does occur, as the wound must be re-opened so that the bleeding vessels can be ligated. This may result in delayed healing by granulation or even in necrosis and sloughing of the wound edges. It is a wise precaution, therefore, to ascertain if there is a history of hemophilia in the immediate family of the patient.

**Postoperative Care** The postoperative care is important though relatively simple. The parts must be kept dry and clean. The adult patient must be kept off his feet for several days, if possible, and should be instructed how to keep his dressing from becoming soiled. In the case of infants, it is incumbent on the nurse in charge to exercise special care to prevent infection and an antiseptic dusting powder or sterile vaseline should be freely used.

**Cautery Circumcision in Adults** In phimosis complicating chancroid or chancre, when venereal warts are present, or in any condition where there is an associated, infectious balanitis, it may sometimes be advisable to perform circumcision by the high frequency cutting current. This method offers several advantages in the prevention of spread of the infection.

In this procedure, the prepuce is cut away with the electrode knife, being careful to remove all the involved tissue, although to do this may mean that the prepuce is cut rather shorter than is sanctioned by the best surgical practice. If any ulcerative tissue remains after the prepuce has been removed, it should be thoroughly cauterized. Sutures usually have to be omitted because of the high degree of infection presented by these cases, but if this is not too great, one stitch may be set at the frenum, another on the dorsum and two at the sides. If there is a bleeder on the frenum, it is best to catch this bleeder with the hemostat.

A wet dressing saturated with any of the ordinary antiseptic lotions should be kept on the entire cauterized area for several days. The patient should be hospitalized for this. An ice-bag is placed on the scrotum and penis, care being taken that the bag is well covered and does not cover the glans.

Sedatives are given to prevent erections. One that Kirwin prefers is as follows:

Sodium bromide	2 drachms
Chloral hydrate	4 drachms
Simple syrup	1½ ounces
Aq. dest. ad	3 ounces

This is to be administered every 2 to 3 hours, 1 teaspoonful diluted in a wine-glass of water. The substitution of the simple syrup for the elixir is advised because alcohol and chloral hydrate have a very depressing effect, in some cases acting like knock-out drops.

### *Surgical Treatment of Penile Carcinoma*

#### AMPUTATION OF THE PENIS AND EXTIRPATION OF THE LYMPH NODES

The surgical treatment of carcinoma of the penis consists in partial or complete amputation of the penis with extirpation of the lymph nodes draining the penile area. The older practice of merely excising the apparently diseased tissue, in cases where the lesion is limited to a small area, has been practically abandoned.

Carcinoma of the penis is discussed on page 300, and the value of radium, or radium and surgery combined, in the treatment of penile malignancy is considered under Radium and Roentgen-Ray Therapy of the Genito-Urinary Tract (p. 1734).

**The Lymphatics Involved.** The lymphatic system of the penis has been described in the section on Anatomy (p. 229), but in view of its importance in the surgical treatment of malignancy it may be well to repeat briefly here.

There is a superficial and a deep lymphatic network. The superficial lymph channels drain the skin and subcutaneous tissue of the penis and pass into the superficial inguinal nodes, usually 18 to 20 in number, lying in Scarpa's triangle below Poupart's ligament and embedded in the superficial fascia. These consist of a higher and a lower group, the upper group lying about parallel to Poupart's ligament and the lower forming a vertical chain on each side of the opening of the saphenous vein. In the region of the cribriform fascia the upper group merges

with the deep inguinal nodes or the deep femoral group lying beneath the fascia lata. The highest of these nodes is found in the crural canal

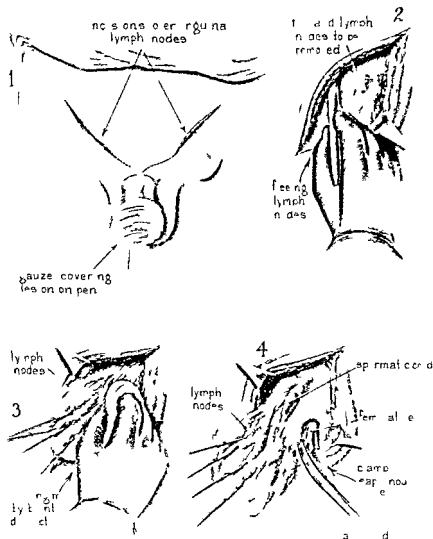


FIG. 50 Radical operation for penile carcinoma. Beginning dissection of the involved inguinal lymph nodes

and frequently projects into the pelvis coming in contact with that part of the external iliac group known as the internal retrocrural node.

The deep network draining the glans penis and the corpora cavernosa empties into the deep inguinal glands which in turn anastomose with the

external iliac group of the pelvis. Some of the vessels of the urethra also drain into the deep inguinal nodes. Others empty into the internal

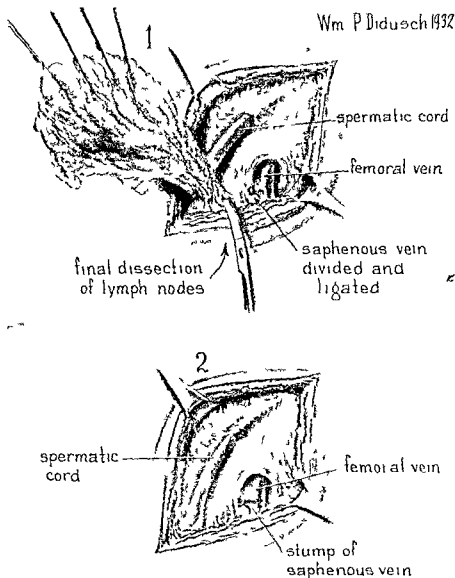


FIG 51 Radical operation for penile carcinoma. Completing dissection of the inguinal lymph nodes

chain of the external iliacs or, passing over the symphysis pubis between the recti muscles, reach the external iliac group by a direct route. A few terminate in the internal retrocrural node.

Since the glans is the most frequent site of penile malignancy, it is of the greatest importance that the deep femoral and iliac nodes be extirpated as well as the inguinal nodes. It is also important to remember

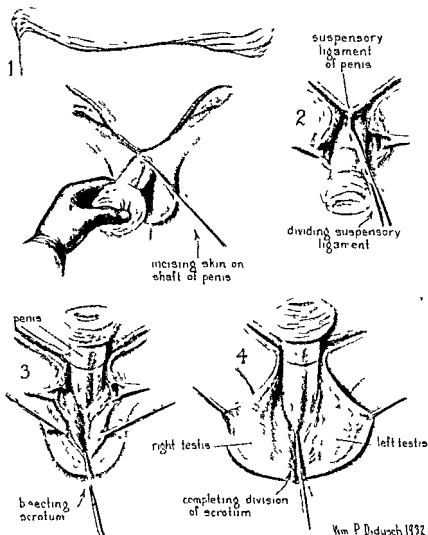


FIG 52 Radical operation for penile carcinoma. A circular incision is made around the base of the penis and extended through the median raphe, bisecting the scrotum

that although the lymphatic drainage of the penis is primarily inguinal, the pelvic nodes may be invaded directly, without involvement of the inguinal nodes, due to the direct communication of the lymphatics of the deep urethral and dorsal vein with the iliac vessels



**Preparation of Operative Field.** Infection is the complication most to be feared in this extensive procedure, and disinfection of the operative field must therefore be unusually thorough. Not only must the penis, scrotum, perineum, and both inguinal regions be shaved and sterilized,

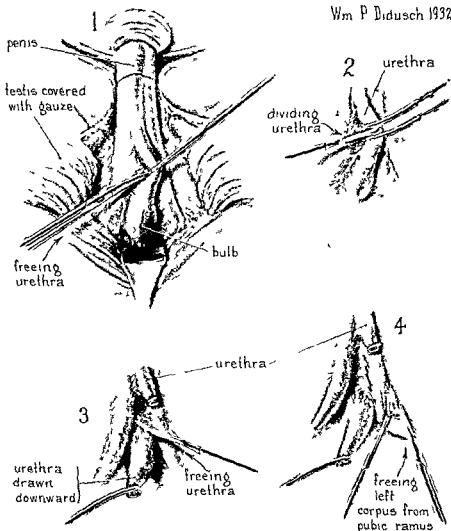


FIG 53 Radical operation for penile carcinoma. The scrotum is retracted laterally, and the entire penis and the urethra down to its membranous portion are dissected free, the crus penis being cut across and the arteries and veins tied off.

but the lower quadrants of the abdomen and the upper part of the thighs must also be prepared. A firmly fastened antiseptic dressing fully enveloping the penis should be placed over the entire operative area some time before the intervention is to take place.

**Technic of Operation** Amputation may be complete or partial, according to the extent of the lesion. In extensive growths, complete

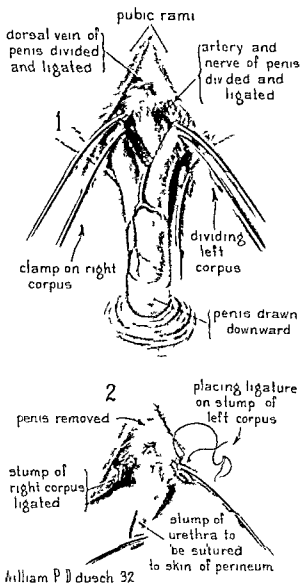
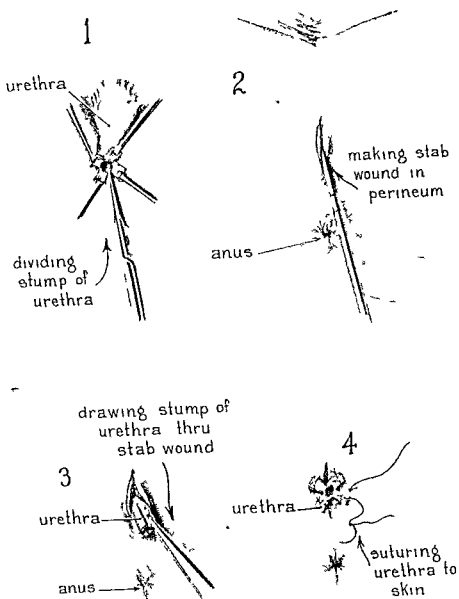


FIG. 54. Radical operation for penile carcinoma. Completing dissection of the penis.

amputation of the penis with transplantation of the urethra into the perineum is advisable. Occasionally, excision may be at the suspensory



Wm P Didusch 1932

FIG 55 Radical operation for penile carcinoma Translating the urethra through a stab wound in the perineum

suture of subcutaneous  
tissues to draw  
scrotum together

1

closure  
of skin

drain

urethra

anus

2

closure  
of skin

drains

scrotum  
sutured

Wm P Didusch 1992

FIG 56 Radical operation for penile carcinoma (1) Closure of the wound as viewed from the perineum showing the transplanted urethra in position the drain placed and the scrotum being sutured (2) Closure as viewed from above

ligament. When it is possible to do so with safety, it is desirable to leave the deep corpora cavernosa and the bulb, as this may enable the patient to remain potent.

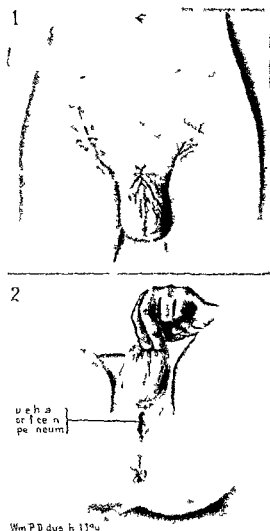


FIG 57 Radical operation for penile carcinoma. Showing the result following excision of carcinoma of the penis and inguinal lymph nodes. (1) Scars in the groin and at the top of the scrotum. (2) The urethral opening in the perineum.

Some surgeons prefer to amputate the penis and extirpate the glands in separate operations.

**Complete Amputation.** An incision is made on each side over the enlarged glands. These are dissected out *en masse*, the bleeding vessels being tied as they are approached, starting from above downward. A

circular incision is made around the base of the penis and extended through the median raphe. The scrotum is retracted laterally, and the entire penis and urethra down to the membranous portion is dissected free, the crus penis being cut across and the arteries and veins tied off.

The urethra is then transplanted through a stab wound in the perineum just under the scrotum and fixed in the skin in such a way that there is at least 15 cm. of the urethra extending beyond the skin. Experience has taught that if this is not done there is likely to be stricture of the urethra.

The newly formed urethra is fixed in position by silk sutures. The entire area is closed, filling in the dead space as well as possible with drainage—Penrose drains being inserted in both incisions in the groin and in the midperineal line.

*Partial Amputation.* The abdominal incision is crescentic, the tips of the horns being at the antero superior iliac spine of each side and the lowest point of the curve about 2 cm. above the root of the penis. Two longitudinal incisions are made upon the dorsum of the penis, extending from the line of amputation below to the curved abdominal incision above. Enough skin for plastic reconstruction of the corpora is undermined and retained.

After raising the skin, the lymph channels and nodes, with the attached fat, are freed by blunt dissection. The cords should be freed with particular care as involved nodes are frequently found along their course. The dissection must be carried up as high as the top of the scrotum and well into that structure, while below it should extend well beyond the nodes in the region of the femoral vessels. The object is to free the entire lymphatic system of the region so that it may be removed with the penis as a single mass and dissemination of the cancer cells thereby avoided. It is highly important that the entire area of malignancy (actual and potential) be removed. Such wide dissection involves destruction of the superficial epigastric veins and of the saphenous vein. The cribriform fascia must be incised and the deepest lying femoral lymph nodes freed completely from both artery and vein. Deep in the pubic tissue the lymph nodes and attached fat must be dissected out as far as the root of the penis.

The suspensory ligament is next divided. Dissection is continued down the shaft from the root of the penis to the point of separation of the corpora cavernosa. The corpora are severed transversely at the level of the symphysis, a tourniquet having first been placed about the

penile shaft to obviate hemorrhage. Both arteries and veins should be clamped and tied as the dissection proceeds. The urethra is freed for at least 2 cm. beyond the point where the corpora are to be amputated. It is then severed transversely, making sure that the point of severance is not less than 2 cm. beyond the limit of potential malignancy. This completes the dissection, so that it should now be possible to lift out in one section not only the amputated penis but also its entire lymphatic connections. If proper attention has been given to the establishing of hemostasis, hemorrhage should give little trouble.

The wound is closed by approximating the sheaths of both corpora cavernosa, which draws them together so that they may be secured in position by interrupted sutures of chromic catgut. The dangers of stricture of the new urethral meatus must be kept in mind when establishing it. Transverse severance of the termination will help to prevent this.

*Removal of Scrotal Contents* Authorities differ as to the wisdom of removing the scrotal contents at the same operation. In our opinion, this is not often necessary and is certainly *never* desirable unless the malignant process is very extensive. Even then the patient's chances of life are much lessened and the psychic effect of emasculation is so bad that it would seem unwise to remove the testicles. Although most subjects of penile carcinoma are beyond the period of sexual activity, the hormones secreted by the testicles are still necessary for proper metabolism, and their removal may profoundly disturb the body mechanism.

*Postoperative Care* The postoperative care does not differ materially from that following any extensive abdominal incision. As the wound is entirely extraperitoneal, many of the dangers of abdominal surgery are eliminated. A self retaining catheter is left in the bladder for a few days, until function of the shortened urethra has been established. The patient is ordinarily able to urinate normally within a few days, or as soon as healing of the edges of the amputated urethra has taken place.

#### ELECTROSURGICAL TREATMENT OF PENILE MALIGNANCY

Though electrocauterization has been employed in the treatment of malignancy for many years with more or less satisfaction, few surgeons have made use of it in the treatment of malignant neoplasm of the penis, if one may judge from the literature. When it is employed, it is usually only for small or moderate sized lesions with slight infiltration. The papillary portion of the tumor is destroyed by fulguration and radon

seeds implanted in the base of the tumor (Radium and Roentgen Ray Therapy of the Genito-Urinary Tract, p 1734)

In far advanced cases, where cure is impossible, diathermy offers a means of removing the foul, fungating mass without danger of disseminating the cancerous cells provides a method of dealing with inguinal metastasis and leaves at least a portion of the penis, sometimes enough to conserve function

A number of authors advocate a combination of electrosurgical resection and radon implantation in the treatment of inguinal metastasis

### *Plastic Surgery of the Penis*

Plastic surgery of any description requires special training in addition to a natural liking and aptitude for the work. It can only be the product of that genius which is 'an infinite capacity for taking pains. When operating on a field so prone to infection as the male external genitalia, this is especially true. Only the minutest attention to every detail will insure success.

Plastic operations upon the penis are chiefly for the repair of extensive trauma, or for the correction of congenital anomalies such as epispadias and hypospadias or of acquired conditions such as impotence and Peyronie's disease.

#### DIVERSION OF URINARY STREAM FROM THE OPERATIVE FIELD

In most plastic procedures upon the penis it is essential that the urine be diverted from the operative field until healing has had time to take place. Thiersch to whom we owe most of the fundamentals of plastic surgery, provided drainage through the perineum when attempting to correct urethral and penile defects. Modern practice inclines toward suprapubic drainage.

It is our invariable practice to divert the urinary stream by suprapubic drainage with a Kenyon double suction tube attached to a vacuum bottle.

#### REPAIR OF PENILE INJURIES

All forms of plastic surgery received a marked impetus through the experiences of World War I, including the repair of penile injuries, which were often very extensive. If, through trauma the penis has been denuded of skin and is then allowed to heal by granulation and cicatrization, the chances are that erection will thereafter be wholly impossible. The extent of the cicatricial contraction may also seriously



interfere with urination and may cause the glans to be so retracted as to bend the penis into a fish hook shape with the meatus facing the abdomen

The two chief considerations in plastic repair of penile injuries are (1) the securing of grafts which will be flexible enough to permit erection without curvature (2) the prevention of infection in an operative field peculiarly exposed to it

**Scrotal Skin Grafts** Grafts secured from the scrotum are certain to become edematous and to thicken immediately after their employment in the repair of penile injuries but experience has shown that eventually their natural flexibility returns. Conserving the blood supply to the skin grafts is of extreme importance for the available skin in this region is so limited that should necrosis occur in the first flap taken no further material can be obtained and failure will be inevitable. A sufficiently wide base for the flap, warm dressings and great care to prevent constriction by twisting are necessary. The dartos must not be included in the skin flap as its muscular fibers and connective tissue render it unsuitable for grafting purposes in this particular connection.

At least 3 weeks must be allowed for union to take place before the flaps are severed from the base. They should be cut away gradually under local anesthesia. The most rigid asepsis must continually be maintained and erections prevented by the application of ice bags and the administration of bromides in large doses.

#### RECONSTRUCTION OF THE PENIS FOLLOWING PARTIAL AMPUTATION

Reconstruction of the penis after partial amputation has been attended with some success. Generalization however is not possible on this subject since each case presents a different set of problems and must be treated as the circumstances demand.

#### OPERATIONS FOR HYPOSPADIAS

**Types of Operations** In the milder types of hypospadias where the penile deformity is slight and normal function not interfered with operation is rarely indicated. In the various plastic procedures employed for the more severe types the twofold object is (1) correction of the penile deformity—the pronounced backward curvature of the penis which is usually present and is due to shortening of the skin in the median line and to the presence of a fibrous cord (2) formation of a urethra to the tip of the glans and the establishing of normal micturition in so far as is possible.

The many and various operations that have been devised for the correction of the different grades of hypospadias may be classified as (1) simple canalization, (2) denudation and suture of the skin edges, (3) the use of penile or preputial flaps, (4) the use of scrotal or abdominal flaps, (5) a combination of the principles embodied in the preceding methods, (6) mobilization and dislocation of the urethra, (7) transplantation of tubes of skin or mucous membrane, veins arteries, the appendix ureter, or urethra

Flaps taken from the penis or prepuce scrotum, abdomen or a combination of these are utilized in the technics of Duplay, Beck Bevan, Cecil, and Ombredanne The use of flaps has been more generally satisfactory than other methods Grafts are made use of in the procedures of Nove Josserand, Mayo and Rochet Transplants from the ureter appendix, or a vein have been used by Legueu Streissler, Marion and McGuire These technics have been so frequently described that their detailed description here is unnecessary

The degree of hypospadias may vary greatly so that all sorts of surgical problems and complications are likely to be encountered and considerable surgical ingenuity is necessary to deal with the factors presented by the individual case

*Operations for hypospadias are best performed just before puberty* Earlier, the penis is too small and after puberty the deformity becomes more marked If the operation is done before puberty, adolescent development of the organs can then proceed along normal or more nearly normal lines

**Ombredanne's Pouch Operation** This is an ingenious method which has been used with very satisfactory results by its author in a great number of cases Others have also reported excellent results by this procedure which can be adapted to various degrees of hypospadias and does not require diversion of the urinary stream If the curvature of the penis requires correction this is first done The operation for hypospadias is done in two stages

*The double flap is made from the neighboring skin surfaces adjoining the abnormal urethral orifice* The flaps are freed brought up on the penis and arranged to form a sac at the extremity of the glans This sac must be closed so completely that no urine can filter through the sutures as this would make useless the employment of the retention catheter, which Ombredanne regards as a 'capital advantage' The flap covering is provided for by a double folding of the prepuce through which a hole

is made for the passage of the glans. The prepuce fold is then sutured to the inferior surface of the penis, which has been denuded by removal of the flaps used to form the sac.

The second step of this procedure is copied from an operation described by Wood (*Medical Times*, January 30, 1875, page 115). Ombrédanne

Wm P Bidusch 1931

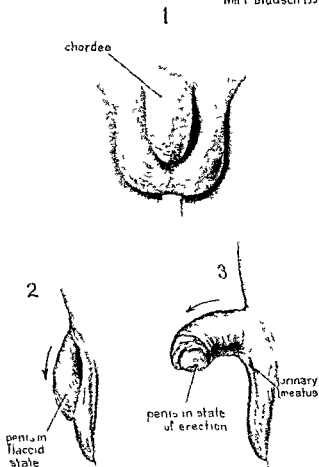
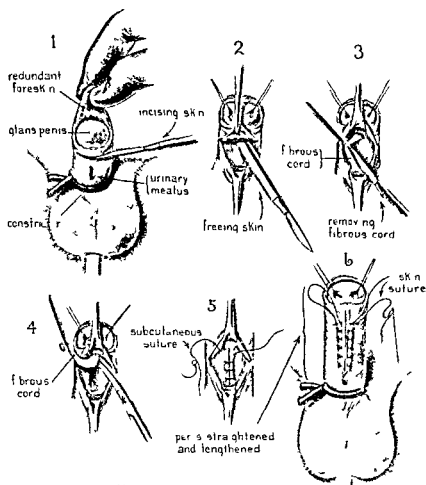


FIG 58 Chordee of the penis associated with penoscrotal hypospadias

found that Wood's flap was not large enough, and derived his in another way, but he accords to Wood precedence in utilizing the perforated and fastened down prepuce to make a cover-flap for the cure of hypospadias.

Ombrédanne claims that his procedure has great advantages over the Duplay operation, which had previously been used by French urological

surgeons for the correction of hypospadias, and is still a popular procedure. He admits that the penis, when the plastic has been completed, is not "so pretty" as those treated by Duplay's method, but claims, on



Wm P Dusch [1931]

FIG 59 Surgical correction of chordee accompanying hypospadias. A transverse incision is made on the under surface of the penis and the skin freed. The fibrous band which causes the downward curvature of the penis is dissected free and removed and the subcutaneous tissues and skin sutured over the defect.

the other hand, that his method is applicable to all young children, never breaks down, and can be completed in a very short time (6 weeks at the longest). Neither a retention catheter nor diversion of the urinary stream is necessary.

Wm P Biduech 1931

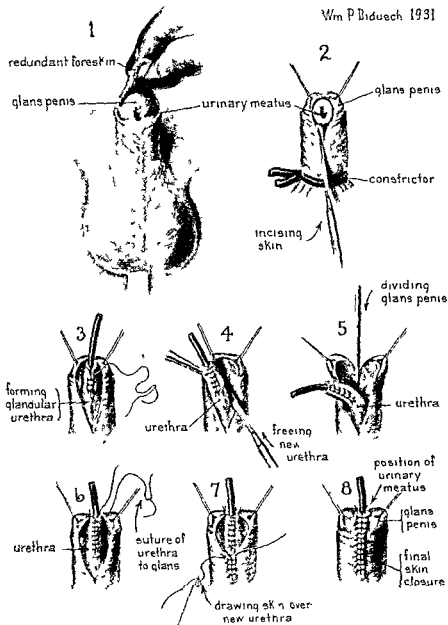


FIG 60 Operation for glandular hypospadias. (1) Shows the abnormal position of the urinary meatus and the redundant foreskin. (2) An incision is made around the hypospadiac meatus and downward along the urethra leaving a cuff of tissue surrounding the meatus. (3) This is sutured over a catheter with malleable wire lengthening the urethra. (4, 5) The urethra is isolated from the surrounding penis and the glans penis completely bisected to relieve tension on the lengthened urethra after it has been placed in the proper position. (6) The glans and shaft of the penis are sutured over the newly formed urethra. (7) Drawing skin over new canal. (8) The completed operation, with the urinary meatus at the tip of the glans.

**Operative Treatment of Chordee, Glandular Hypospadias, and Penile Hypospadias** In figures 58 and 59 are illustrated the downward curvature of the penis present in the severer grades of hypospadias and a surgical method of correcting the deformity

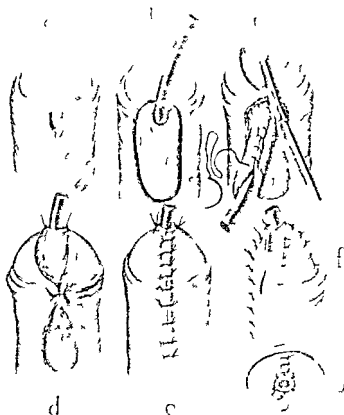


FIG. 61 Operation for correction of penile hypospadias. (a) Shows the location of the urinary meatus. (b, c) An anterior urethra is constructed from a penile skin flap which is sutured over a catheter. (d) The glans penis is bisected and the newly formed urethra fixed in position in the glans which is sutured over it. (e) (f) Shows the course of the urethra. (g) The urinary meatus at the tip of the glans.

Glandular hypospadias does not require correction as a rule. Occasionally, however, operation is advisable in which event we recommend the procedure illustrated and described in figure 60.

An operation for the correction of penile hypospadias is illustrated in figure 61.

**Three-stage Method for Penoscrotal Hypospadias** For the past 11

years we have been using the following three stage method for the correction of penoscrotal hypospadias, with excellent results

*The first stage consists of diversion of the urinary stream by means of*

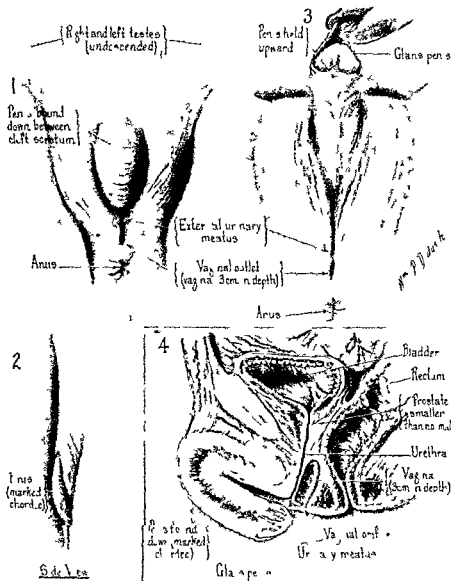


FIG 62 Penoscrotal hypospadias with marked chordee three-stage plastic operation for its correction. The 17 year-old boy whose case is illustrated in this and the following 7 plates had been reared as a girl until 14 years of age. In addition to the hypospadiac condition both testicles were undescended and there was a small vagina just below the urinary meatus. In every other way the boy was masculine in appearance as well as in temperament. The urethral anomaly was corrected by the three-stage operation shown in figures 63 to 68 the vagina removed and the testicles placed in their proper position in the scrotum (Case of Lowsley and Begg)

a suprapubic cystostomy, and formation of a tube from scrotal integument. A wide strip of scrotal skin, extending from the anomalous opening laterally and downward as far as necessary, is partially freed, and a tube constructed by approximating the edges over a catheter with

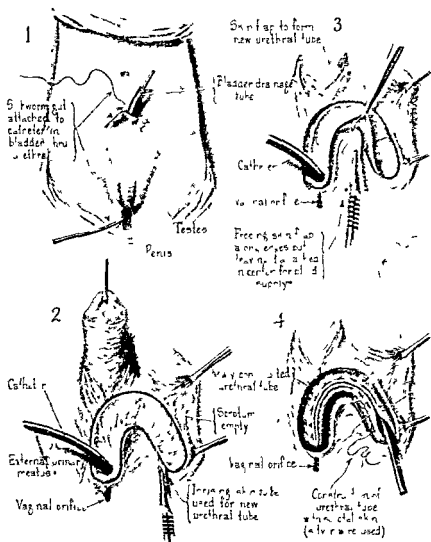


FIG. 63 Three-stage operation for penoscrotal hypospadias. First stage (1) The urine is diverted by a suprapubic cystostomy. (2, 3, 4) A urethral tube is constructed from a wide flap of scrotal skin, which is partially freed and the edges sutured together over a catheter with malleable wire. (Lowsley and Begg.)



interrupted mattress sutures of malleable wire This tube is covered over with scrotal skin and left in place long enough for firm healing. The catheter is removed and a piece of silkworm gut is left in the tube until the final stage of the operation

In the second stage the deformed penis is relieved of the scar tissue

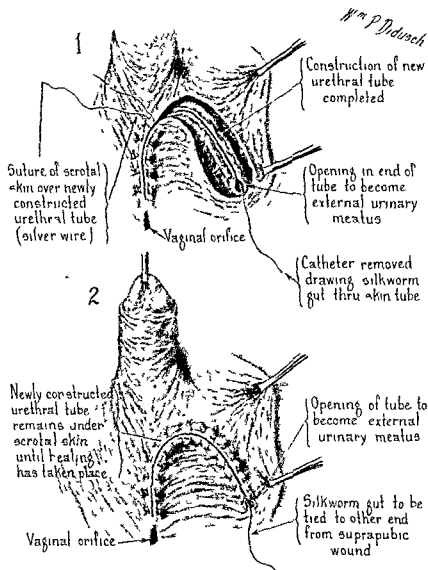


FIG 64 Three stage operation for penoscrotal hypospadias Completing first stage. The newly formed urethral tube is covered over with scrotal skin and left until healing has taken place The catheter is removed and a piece of silkworm gut left in the tube until the final stage of the operation (Lowsley and Begg)

which causes a congenital chordee. The overlying skin is dissected away from the buried tube, the glans split, and the penis brought down and sutured over the newly formed urethral tube.

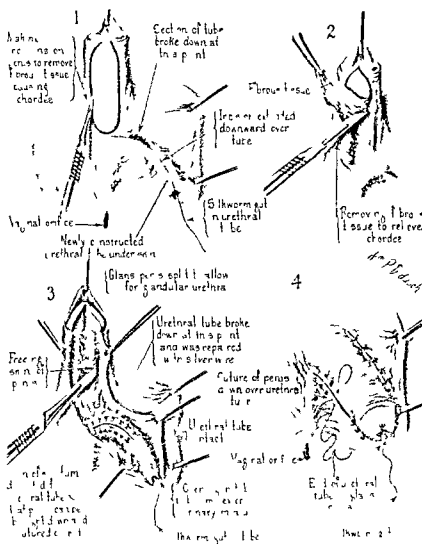


FIG. 65. Three-stage operation for penoscrotal hypospadias. Second stage of operation. (1-2) The fibrous tissue causing chordee is removed and the skin incision extended downward over the new urethral tube. (3-4) The glans penis is split, the overlying scrotal skin dissected from the tube and the penis brought down and sutured over the tube. (In this case the new urethra broke down at one point and was repaired with silver wire.) (Lowsley and Begg)

In the third stage the penis and urethral tube are freed from the scrotal bed, after remaining in position long enough for the new tube to become firmly fixed to the penis. The penile and scrotal skin is then sutured over the raw area. A No 18 or 20-French catheter is pulled through

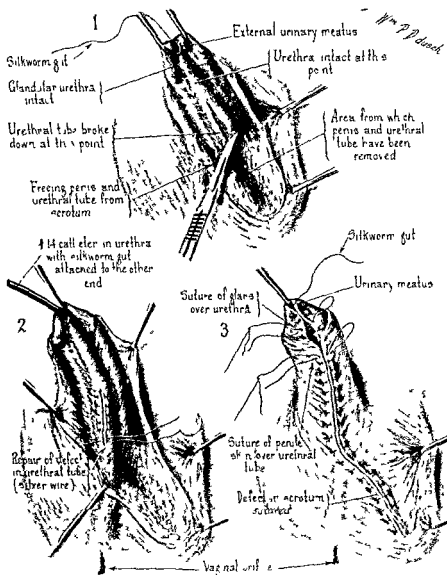


FIG. 66 Three stage operation for penoscrotal hypospadias. Third stage of operation (1) After having remained in position long enough for the new tube to become firmly fixed to the penis, the penis and urethral tube are freed from the scrotum. (2) Showing repair of defect in the urethral tube. (3) The penile and scrotal skin is sutured over the urethra and the defect in the scrotum. (Loxley and Begg)

the urethra by tying it to the piece of silkworm gut which has remained in the new tube since the first stage of the operation, being fixed at the suprapubic incision and at the meatus of the new urethra. The catheter is fixed in a proper position to drain the bladder and the suprapubic

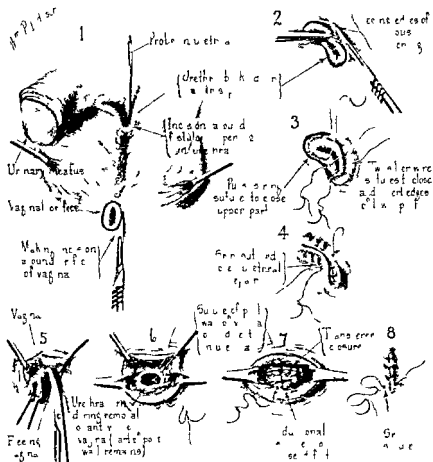


FIG. 67. Penoscrotal hypospadias. The anomalous vagina in this case is removed and a defect in the urethra repaired. (Lowsley and Begg.)

wound allowed to heal, which it usually does promptly. The catheter is then removed.

This three stage procedure is well illustrated in figures 62 to 68 inclusive.

Of late, we have been combining the first and second stages of this operation, with success.

**Postoperative Care.** Careful postoperative watching and care are important factors in the success of the operation. Sounds are passed through the new urethra at frequent intervals, experience having taught us that the newly formed meatus shows a decided tendency to become strictured.

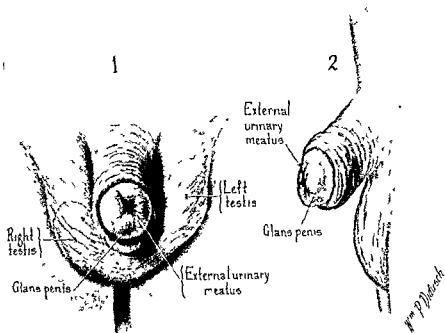


FIG. 68 Penoscrotal hypospadias. Shows the straightened penis, with the urinary meatus in the center of the glans and the testes in their normal position in the scrotum (Lowsley and Begg)

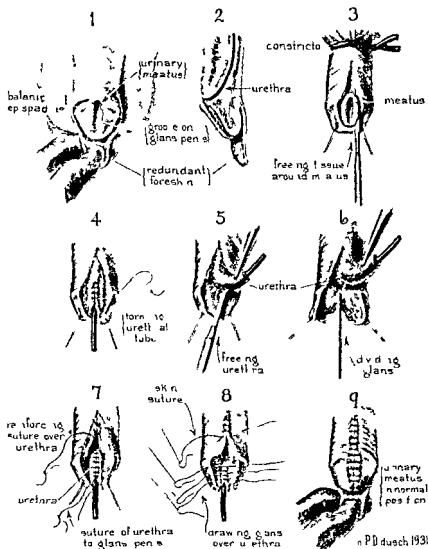
#### OPERATIONS FOR EPISPADIAS

The treatment of epispadias, like that of hypospadias, aims at correction of the deformity and restoration of normal function, but it presents an even greater problem since partial or complete incontinence is generally present.

The best time for operation, we believe, is just before puberty, unless incontinence is present, in which event the operation should be done as early as possible.

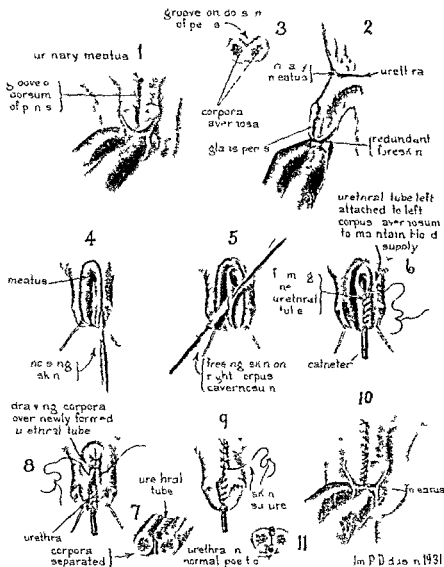
Many operations for the correction of epispadias have been described. The ones which have received the most attention are those proposed by Beck, (1906), Barney (1916), and Young (1917). Young's operation has been performed by us in several cases, with good results.

**Repair of Glandular Epispadias.** In those extremely rare cases in which the malformation is merely a defect in the glans, operation consists in approximating the tissues above the urethral trough, in order that the urethra may open at the proper site at the tip of the glans (Fig 69)



**FIG 69** Operation for glandular or balanic epispadias (1 2) Showing the epispadiac condition (3 4) The tissues around the urinary meatus are freed and the edges sutured together over a catheter to form a urethral tube (5 6 7 8) The anterior urethra is isolated the glans penis divided and the urethra fixed in its normal position in the glans which is then sutured over it (9) The urinary meatus in its normal position at the tip of the glans.

**Young's Operation for Penile Epispadias** The penis is held in position by two sutures placed in the glans (Fig 70) On the left side of



**FIG 70 Operation for penile epispadias** (1 2 3) Showing the epispadiac condition (4 5) On the left side of the urethral groove an incision is made through the skin and down to the corpus cavernosum On the right side an incision is carried down between the corpora The skin is freed completely on the right side and partially on the left (6 7) The freed right margin of the urethral groove is brought over to the left margin and the edges sutured together over a catheter converting the urethral groove into a tube (8) The left corpus is rotated so as to bring the urethra into its normal position below and between the corpora, which are sutured over it (9) The outer edges of the skin incision are then approximated (Young's Practice of Urology)

the groove upon the dorsum of the penis an incision is carried through the skin down to the corpus cavernosum. On the right side an incision is carried down between the corpora until the skin of the under surface of the penis is reached. The skin flap is freed completely on the right side and partially on the left and the right edge of the urethral groove brought over to the left edge and the cut margins united over a catheter by continuous sutures of chromic catgut. The original urethral groove is thus converted into a tube which is however still attached by a broad connection to the underlying left corpus along its entire length. The left corpus is now rotated so as to bring the new urethra into its normal position between and below the two corpora which are sutured over it with interrupted stitches of chromic catgut. The two outer edges of the original incision are brought together in the midline. The end result is a penis and glans almost normal in appearance.

A most important feature of this operation is the securing of an adequate blood supply by leaving the skin for the new urethra attached to one corpus cavernosum.

Postoperatively the urethra should be dilated at frequent intervals to prevent stricturing.

**Treatment of Accompanying Incontinence** The incontinence that often accompanies epispadias may sometimes be cured by removing a wedge-shaped piece of tissue from the vesical orifice and suturing the cut edges together making a water tight sphincter (Surgical Treatment of Incontinence of Urine p 1137). A patient operated upon by Lowsley in 1924 at the age of 12 years was still in excellent condition when last seen 9 years ago. He was then 22 years old and could hold his urine for 4 hours when up and all night while in bed.

In certain cases in which the incontinence can not be cured by the above method transplantation of the ureters may be advisable.

#### LOWSLEY'S OPERATION FOR IMPOTENCE

**Indications** This operation has no effect on impotence due to syphilis, cerebrospinal lesions or glandular deficiency. It does however give relief to those who are impotent as a result of (1) traumatism to the perineum following an external blow or a surgical operation (2) inflammatory lesions of the perineum resulting in extensive scar formation (3) lack of muscle tone (4) advancing age. Our particular concern is with those who are impotent because of injury to the perineum and the older group of men who have ample libido, normal testicles and hence



normal secretion of the sex hormone, and no interference with the nervous tracts involved in the sexual act, but who cannot have erections because of the failure of the physiological activities of this part of their anatomical structure

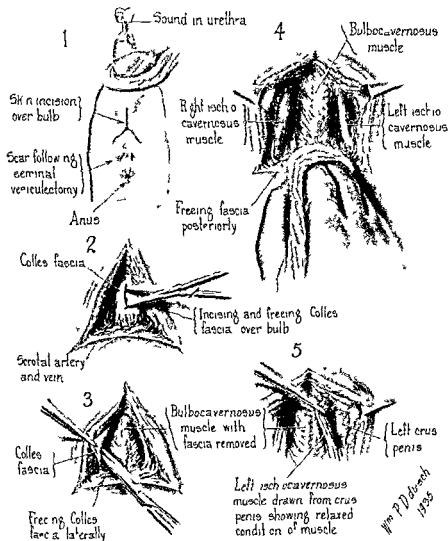


FIG 71 Lowsley's operation for impotence (1) An inverted Y incision is made over the bulging part of the perineum (2 3 4) The incision is deepened through fat and fascia until the corpus spongiosum (surrounded by the bulbocavernosus muscle) and the crus penis on each side (surrounded by the ischiocavernosus muscle) are exposed. (5) Showing relaxed condition of left ischiocavernosus muscle

The most spectacular cures have been achieved in the case of those rendered impotent by traumatic injuries to the perineum, whether due to operation rupture of the urethra by straddle injuries, or violence

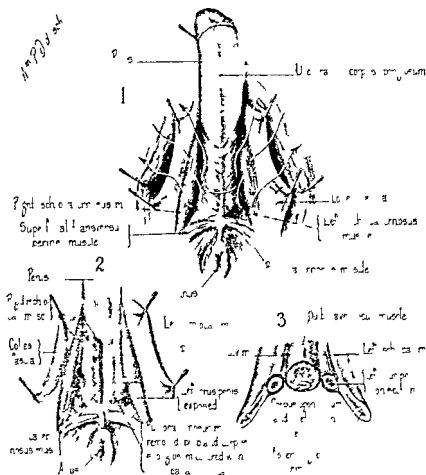


FIG "2 Operation for impotence (1) Showing anatomy of the perineum and the muscles involved in the plication procedure also the method of placing plication sutures. (2) Part of bulbocavernosus muscle and left ischiocavernosus muscle removed exposing bulb and corpus spongiosum and part of left crus penis (3) View on cross section showing the muscles surrounding the corpus spongiosum and the crura

**Technic of Operation** A series of animal experiments were first performed, which proved that the ischiocavernosus muscle on each side and the bulbocavernosus muscle were essential to the function of erection (Physiology, p 241) The results of the operations on animals were so

striking that a series of operations in humans was done. The technic of the operation is as follows:

The anesthetized patient (spinal or sacral anesthesia) is placed on the operating-table in an exaggerated lithotomy position, and a No 19-French sound is passed into the urethra

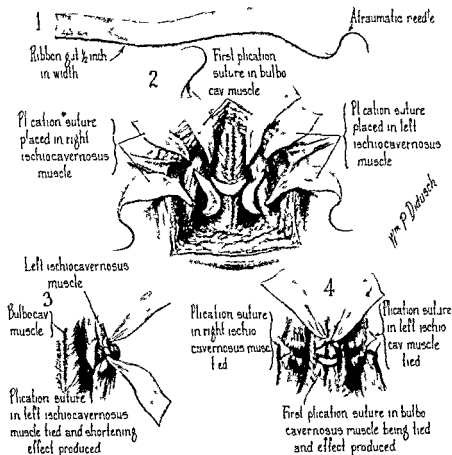


FIG 73 Operation for impotence (1) Ribbon gut, threaded on needle, to be used in plication (2) Method of placing the ribbon gut plication sutures in the bulbocavernosus and the ischiocavernosus muscles (3) Shortening effect caused by plication suture in left ischiocavernosus muscle (4) Plication sutures placed in right and left ischiocavernosus muscles and the tightening effect produced by placing plication suture in bulbocavernosus muscle

An incision is made over the bulging part of the perineum, extending in the midline from a point about 10 cm from the anal margin down toward that structure for about 5 cm. A branch is then made laterally on each side to a point just above the attachment of the crus penis, the

completed incision resembling an inverted Y. The incision is deepened through fat and areolar tissue until the corpus spongiosum, surrounded

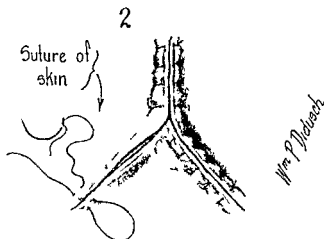
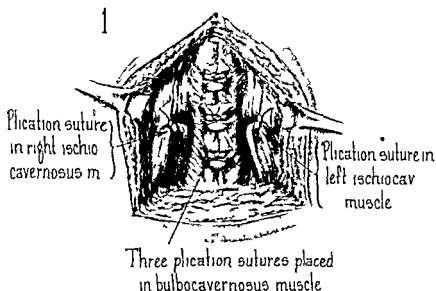


FIG 74 Operation for impotence (1) All plication sutures placed and tied (2) Final skin suture

by the bulbocavernosus, and the crus penis (corpus cavernosum) on each side surrounded by the ischiocavernosus, are exposed

Chromic ribbon gut, studded with an atraumatic needle, is inserted into the lateral edge of the bulbocavernosus muscle, pulled across the belly of the muscle, and passed through the other side, with just sufficient strain to plicate the muscle and produce the exact amount of pressure to reinforce any contraction necessary to aid in producing an erection. Two more similar stitches may be required to tighten the whole muscle. A figure-of-eight ribbon-gut suture is inserted into the ischiocavernosus

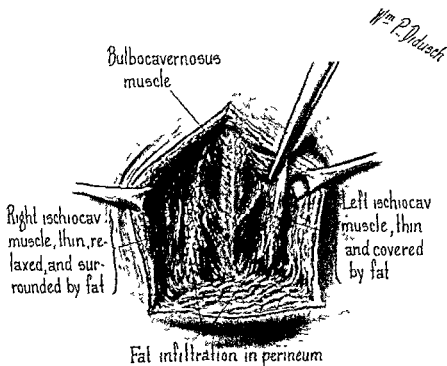


FIG 75 Operation for impotence Condition present in perineum of an old man. The muscles are thin and relaxed and there is definite fat infiltration.

muscle on each side, care being taken not to injure or unduly compress the fairly numerous nerves and blood vessels in this area. By tightening the suture, a reef is taken in the muscle, thus shortening it by approximately 1 inch.

The wound is closed in layers without drainage.

An incision 4 cm. long is then made over the suspensory ligament, which is exposed and freed by blunt dissection. A compression suture is placed in the two leaves of the suspensory ligament of the penis, caus-

ing a moderate persistent compression which prevents a too rapid flow of blood out of the organ (This we do because three of the patients in

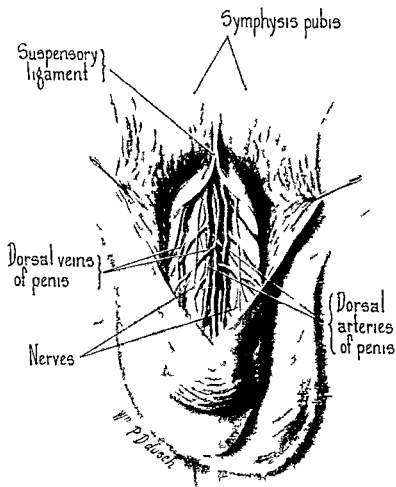


FIG. 6 Operation for impotence. Showing the suspensory ligament and the arteries, veins and nerves of the dorsum of the penis.

our original series were relieved at first and then became less efficient due to the fact that the dorsal veins of the penis enlarged and allowed the collateral circulation to carry off the stasis too freely.)

In order to accomplish the desired result the operation must be skillfully performed with just the right amount of shortening of the muscles. If the muscles are too tight a constant painful erection will result if

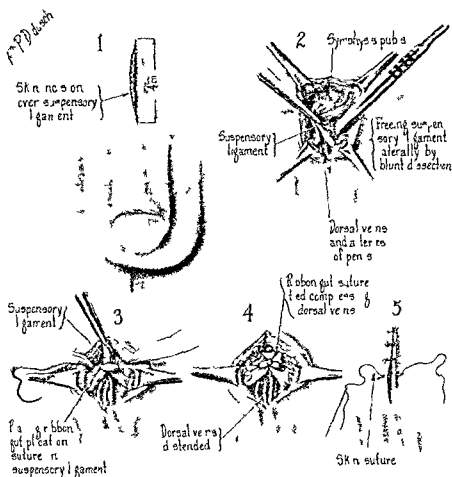


FIG 77 Operation for impotence. Placing a compress on suture in the suspensory ligament (1) Skin incision (2) Blunt freeing of suspensory ligament around vessels. (3) Placing ribbon gut suture to constrict suspensory ligament around vessels (4) Ribbon gut suture tied compressing dorsal veins (5) Skin closure

not tight enough satisfactory erections will not be produced. The success of the operation apparently depends upon the use of chromic ribbon gut which does not tear through the delicate muscles as does ordinary twisted catgut.

## OPERATION FOR PEYRONIE'S DISEASE

Plastic induration of the penis (Peyronie's disease) is curable by removal of the fibrotic tissue of the septum between the corpora cavernosa unless there is too great involvement of the lateral wall of Buck's fascia. Operation is not advisable if the plaques of induration extend too far laterally on Buck's fascia as a new deformity of the penis is thereby created.

**Technic of Operation.** The anesthesia used is usually spinal.

A tourniquet is placed around the proximal portion of the penis. A midline incision is made on the dorsum of the penis extending from the penopubic junction to the sulcus of the glans penis; this is deepened to the fibrotic tissue and extended laterally on each side to the curved portion of Buck's fascia. The thickened tissues of the posterior portion of the septum are then dissected free, care being taken to avoid entering the corpora cavernosa any more than is necessary to remove the offending fibrotic tissue. It is customary to isolate the tissues of the septum at its middle point and continue the dissection both proximally and in a distal direction.

After the indurated septum has been removed, small pads of fat are applied to the breaks in Buck's fascia which expose the venules of the corpora cavernosa, and the wound is repaired by suturing the cut edge of Buck's fascia on each side to its fellow of the opposite corpus cavernosum with catgut or silk.

The tourniquet is released, and bleeding points are ligated or repaired with additional fat. The subcutaneous tissues are sutured over the repair and the skin is closed with silk.

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## CHAPTER X

### EMBRYOLOGY, ANATOMY, ANOMALIES, AND PHYSIOLOGY OF THE SCROTUM AND SCROTAL CONTENTS

#### A EMBRYOLOGY

##### 1 Embryology of the Scrotum

The scrotum is the pouch of skin and tissue which holds the testicles and their adnexa, providing them with an efficient protective investment and maintaining their relation to the penis. Its embryonic development has already been touched upon in connection with the embryology of the penis (p. 223), with which it is closely related.

Briefly. When the embryo is about 21 mm long, a pair of rounded lateral ridges—the *labioscrotal swellings*, or outer genital folds—are visible, one on each side of the base of the phallus, from which they are separated by a Y shaped groove. During the 38 to 45 mm stage the phallus elongates and the primitive urogenital opening is removed farther and farther from the anus by the fusing of the margins of the urethral folds (inner genital swellings) in the midline. The fused margins of these folds constitute the perineal and penile raphe.

During the elongation of the phallus, the labioscrotal swellings gradually migrate downward and assume their permanent position between the base of the penis and the perineal body. They now become the *scrotal swellings*. The *scrotal raphe* is formed by fusion of the tissues of the labioscrotal swellings within the septum originally formed by the union of the urethral or inner genital folds. In the female the labioscrotal folds remain separate, forming the labia majora; in the male, their fusion results in formation of the *scrotum*. Though united in the midline, the bilateral origin of these scrotal swellings always remains plainly evident.

As the scrotum develops, its mesenchyme differentiates into layers similar to those composing the abdominal wall. The two vaginal sacs into which the testicles are eventually received, are formed by a prolongation into the scrotum of the vaginal processes of the peritoneum.

## 2 Embryology of the Testicle and Epididymis

Though generally referred to as separate structures, the testicle and epididymis should be considered together because of their close embryological, anatomical, and clinical relationship

The testicle is an important organ of internal secretion in addition to being the reproductive gland of the male. It arises from the nephrogenic cord, along with the müllerian duct and the mesonephros and its duct. The cranial end of the mesonephric duct becomes the vas deferens and the epididymis, the tubular system which carries the sperm to the outside. The few surviving tubules of the mesonephros unite with the tubules of the rete testis to form the urogenital union, a conjunction of reproductive and excretory structures. Caudally, the mesonephric duct becomes the seminal vesicle and ejaculatory duct. The müllerian ducts in the male degenerate almost completely, only their upper and lower ends persisting, the former as the *hydatid of Morgagni*, a small sac like body attached to the upper end of each testis near the epididymis. The lower ends of the two ducts fuse to form the *uterus masculinus*.

**Development of Testicle and Epididymis** Embryologically, the reproductive organs of both sexes are closely associated. The first evidence of the gonads is in the region known as the *urogenital fold*, an intermediate cell mass projecting into the dorsal portion of the coelom, or primitive abdominal cavity. The urogenital fold subsequently is split longitudinally into a lateral *mesonephric fold* and a median *genital fold*. When the embryo is 13 mm long the genital fold has become differentiated into an inner epithelial mass and an outer layer of germinal epithelium. The epithelial core is active, but the surface epithelium is inactive.

Sex differentiation is first apparent in embryos about 13 mm long (seventh week). At this time, the inner mass is seen to consist of an anastomosing network of epithelial cords. These branched cords are separated from the superficial epithelium by a layer of somewhat dense connective tissue, the primordium of the *tunica albuginea*. It is this structure of cords and sheath that identifies the organ as male.

The epithelial cords converge toward the mesorchium to form the *rete testis*. The cords of the testis are composed of two kinds of cells, *indifferent cells* and *genitaloid cells*. The inner ends of the testis cords are composed of indifferent cells, the remainder contains indifferent cells interspersed with the genitaloid cells. The genital or germ cells make their original appearance not in the epithelium of the genital ridge, but

in the caudal end of the body. When the embryo is about 3.5 mm long these cells begin to migrate by way of the entodermal gut and mesentery into the epithelium of the genital fold. These cells are called primordial germ cells.

The connective tissue sheath eventually dips down between the cords forming septa which unite toward the rete testis to form the *mediastinum testis*. Within the septa the testis cords gradually arrange themselves radiat to the mediastinum and about the sixth or seventh month begin to form lumina. The lumina first appear in the peripheral ends of the cords and eventually connect with the lumina of the indifferent-cell mass forming the rete testis.

The distal portions of the tubules become greatly elongated and convoluted forming the *tubuli contorti* which later become the *seminiferous tubules*. The proximal portions remain straight and form the *tubuli recti* as they enter the rete testis. The rete testis thus becomes a network of straight tubules which connect with the tubuli collectivi of the epigenitals at the *urogenital union*.

The walls of the tubules are composed of indifferent cells and the larger reproductive or *genital cells* which have been developed from the genitaloid cells of the testis cords. The genital cells increase in growth up to birth when they degenerate indifferent cells alone lining the walls of the tubules until the onset of puberty. A new generation of genital cells then forms which develop into the spermatozoa. The cellular structure of the testicle is discussed further on page 368.

The *mesonephros* is observable in embryos 2.5 to 30 mm in length. It begins to degenerate from the cranial end in embryos between 10 and 20 mm in length. Altogether 83 pairs of tubules form of which only 26 pairs survive in embryos 21 mm long. These are divided into two groups. The upper group constitutes the *tubuli collectivi* of the epigenitals. By the end of the sixth month their lumina have become continuous with those of the rete testis and the mesonephric tubules thereafter function in the male as the *ductuli efferentes* of the epididymis. The lower group of mesonephric tubules becomes vestigial in both sexes persisting in the male as the *paradidymis* and *vas aberrans*. The ductuli efferentes remain straight at the end toward the testis but are coiled at the epididymal end so as to form the wedge-shaped *constrictusculosi*.

The major portion of the epididymis develops from the cranial end of the mesonephric duct one part of which becomes greatly convoluted

and forms the *body* and *globus minor* of the epididymis. The remainder is converted into the vas deferens.

**Descent of the Testicle** The position finally occupied by the testicles is very different from that which they possess in the earlier stages of development.

During the first stages of intrauterine life, the testicles develop in the abdominal cavity, posterior to the peritoneum, by which they are covered only in front and at the sides. They are at first elongated structures, extending below the diaphragm. Their cranial portions atrophy and their caudal ends grow.

By the end of the third month, the testicles lie in the mid abdomen, being connected with the anterior abdominal wall by four attachments: the mesorchium, or epigonal portion of the genital fold, the mesonephric fold, the inguinal fold, and finally by the inguinal crest. Within the fold thus formed there gradually appears at first in separate parts a cord of closely compacted spindle shaped cells, which extends from the caudal end of the testicle through the inguinal canal to the scrotal integument. It begins to form at about the third month. At this time, the ligamentum testis develops in the genital fold and extends from the caudal end of the testis to the mesonephric fold. The chorda gubernaculi forms in the inguinal fold and is continued to the integument of the scrotum by way of the ligamentum scroti. The ligamentum testis is connected to the chorda gubernaculi by the development of a cord in the mesonephric fold. Thus there is formed a continuous cord—the *gubernaculum testis*—which is composed of the ligamentum testis, a mesonephric cord, the chorda gubernaculi, and the ligamentum scroti. The function of the gubernaculum testis is apparently to guide and to some extent to draw the testicle from the abdomen into the scrotum. As fetal development proceeds the lower section of the gubernaculum enlarges but above degeneration and atrophy take place.

At about the time the gubernaculum begins to develop a sac like pocket—the *processus vaginalis*—appears in each side of the anterior abdominal wall. During the sixth month these peritoneal prolongations evaginate through the abdominal wall and inguinal canal into the scrotum, preceding the testicles.

During the seventh to ninth months the testicle descends into the scrotum by a complex process in which the gubernaculum appears to play an important part. The descent is accomplished by atrophy and

contraction of the gubernaculum, the resulting shortening serving to draw the testicle into the scrotum. Intra abdominal pressure, and the relative excess growth of the embryo compared to the gubernaculum, are apparently also important factors in the mechanism of testicular descent.

Since the gubernaculum and testis are retroperitoneal in position, they remain beneath the posterior wall of the processus vaginalis, the testis being covered, after descent, by a reflected fold of the processus.

The narrow canal which connects the processus vaginalis with the abdominal cavity closes, the now isolated vaginal sac becoming the *tunica vaginalis*, the serous investment of the testicle. Of the upper opening of the processus vaginalis there remains but a frail thread which may be traced along the spermatic duct, where it mingles with the tissues forming the spermatic cord. Sometimes, however, the canal fails to close or disappears only in part, thus giving rise to *congenital hernia* for if this peritoneal pouch remains open the tunica vaginalis has a free communication with the general peritoneal cavity.

As the testicle descends, it carries with it the ductus deferens (primitive mesonephric duct) the spermatic vessels and the lymphatics; these with their surrounding connective tissue constitute the *spermatic cord*.

Descent of the testicles is normally complete at birth. Interference with development, from whatsoever cause, may bring to bear influences which will retain them in the abdominal cavity or within the inguinal canal. When this occurs, we have the condition known as *cryptorchidism*. Sometimes the testicle descends to the inguinal canal and thence deviates to some abnormal position, giving the condition known as *ectopia testis* (see Cryptorchidism, Ectopia of the Testicle, p. 376).

*Influence of Hormones on Testicular Descent.* The mechanism of testicular descent as described above, has been accepted for many years, but later experimental work seems to indicate that the descent of the testicle may be influenced materially by hormones developed during growth of the child. Clinically, it has been observed that the testicles in *cryptorchids* sometimes descend following the injection of a suitable dose of a gonadotropic hormone.

In mice and rats the testicles do not descend until puberty, which suggests the possibility that the male hormone exerts an influence on testicular descent in these animals. Additional strength is given to this view by the knowledge that in certain rodents the testes remain in the abdomen and descend only during the rutting season. It is also known

that scrotal hernia may develop in mice treated with the ovarian hormone (estrin, folliculin) Kojama showed that testicular descent does not occur in hypophysectomized immature male animals, and Rose observed that severing the gubernaculum testis in experimental animals was followed by normal descent of the testicle in the majority of cases. It is difficult to reconcile these facts with the generally accepted theory of testicular descent.

Probably several factors contribute to the normal descent of the testicles. Undoubtedly the hormonal factor is of considerable importance. In addition the development of the scrotum and its investing pouches, the gubernaculum testis, the loosening and subsequent closing of the rings of the inguinal canal, the actual and relative growth of the body with that of the testicles, and increased intra abdominal pressure, all may influence the normal descent of the testicles.

## B ANATOMY

### *1 Anatomy of the Scrotum*

**Structure of the Scrotum** In addition to its external integument the scrotum consists of three layers separated by connective tissue (1) the outer layer or *dartos*, which is separated by the external spermatic fascia from (2) the middle layer or *cremasteric*, which, in turn, is separated by the internal spermatic fascia from (3) the inner layer or *tunica vaginalis*.

**The Scrotal Skin** The skin of the scrotum is very thin, deeply pigmented, marked by numerous rugae and after adulthood, sparsely covered with coarse hair. It contains many sebaceous and sudoriferous glands, which always show a high degree of development, and is abundantly supplied with elastic and smooth muscle fibers. From either side the median raphe the loose, distensible skin lies in a multitude of tiny transverse folds, which can be easily smoothed out when the integument is slightly stretched.

**The Dartos** Directly beneath the skin lies the dartos—a reddish highly vascular layer of elastic tissue intermingled with unstriped muscle fibers and devoid of fat. It is continuous with the suspensory ligament and superficial fascia of the abdomen, groin and perineum. The dartos forms a separate compartment for each testicle which unite in the mid line to form the septum scroti. The rugae of the scrotum are due to the prevailing longitudinal direction of the muscle fibers of the dartos. In normal health and virility, these fibers are always somewhat contracted, and stimuli, such as cold, exercise, and various emotions will induce

still greater contraction In the aged or debilitated, there is permanent relaxation

Directly beneath, and closely adherent to the dartos is a fatless layer of laminated connective tissue, the *external spermatic (intercolumnar) fascia* At the external inguinal opening this layer converges with the strong fibrous bands which cross the columns of the external inguinal ring Like the dartos this fascia is prolonged over the penis and perineum, being continuous with the superficial perineal fascia below and with the superficial fascia covering the symphysis pubis above

*The Cremasteric Fascia* The cremasteric or middle spermatic fascia covers the cord and testicle with a well defined fibromuscular investment It is composed of areolar and elastic tissue arranged in a strong double lamina enclosing longitudinal bundles of striped muscle fibers which extend to the external inguinal ring Underneath, opposite the lower extremity of the testicle this middle layer of the scrotum blends with the dartos Contraction of these muscle fibers takes place under the stimulus of emotion, or when the abdominal muscles are concerned in expiration

Beneath the cremasteric fascia lies a delicate connective tissue, the *internal spermatic (infundibuliform) fascia*, which is an offshoot of the transversalis fascia Together with a laminated prolongation of the subperitoneal tissue, it closely invests the elements of the cord and testicle, lying above the tunica vaginalis, with which it fuses

*The Tunica Vaginalis* The innermost layer of the scrotum, or tunica vaginalis, is the lower end of the peritoneal tube through which the testicle makes its descent being all of that structure which survives intrauterine life The outer or parietal layer forms the lining of the scrotal sac and is closely adherent to the infundibuliform fascia The inner or visceral layer is thinner, and invests the testicle and most of the epididymis Toward the lateral surface of the testicle it dips in between the testicle and epididymis, forming a pocket—the *sinus epididymis*

*The Blood Vessels of the Scrotum* The vascular supply of the scrotum is abundant The skin and the dartos receive their circulation from the external pudic branch of the femoral artery on each side and the superficial perineal branch of the internal pudic artery A special branch from the deep epigastric artery supplies the cremasteric and the intervening fascial layers

The scrotal veins empty into the internal pudic and long saphenous veins and the dorsal vein of the penis



**Innervation of the Scrotum.** The nerves of the scrotum are offshoots of the genitocrural nerve of the lumbar plexus and the superficial perineal nerve of the sacral plexus

**The Scrotal Lymphatics** The lymphatics of the scrotum anastomose with those of the penis and drain into the inguinal and femoral nodes. There is no connection between the lymphatics of the scrotum and those of the testicles and their tunics

**Surgical Importance of Scrotal Anatomy** The anatomy of the scrotum is of special interest for three reasons (1) Due to the close adherence of the dartos to the skin, injury to the skin is likely to result in its inversion, making perfect apposition difficult when suturing incisions in this area, (2) because of the loose texture of the cellular tissue lying within the dartos, and the vascularity of the scrotum, the bleeding incident to trauma is usually very free, the tissue spaces fill quickly and a hematoma may form with great rapidity, sometimes causing serious trouble and greatly complicating the surgeon's task, (3) the looseness of the areolar tissue makes possible rapid and extensive edema from comparatively slight causes, and if septic infection occurs, it spreads quickly and sloughs widely

## 2 *Anatomy of the Testicle and Epididymis*

**The Testicle** The testicles are two oval, grayish white organs situated one on each side in the scrotum, the left gland being usually somewhat lower than the right. They average 4 to 5 cm. in length by 2.5 to 3 cm. in width. Their anterior surface is free and their posterior border covered by the epididymis

Normally, at birth the testicle hangs suspended in a cavity known as the *cavum vaginale*, from which it is separated by the visceral layer of the tunica vaginalis. This visceral layer continues over the epididymis as far as its lateral border, where it is reflected forward so as to become the parietal layer, the difference in the extent of these two layers being sufficient to permit the formation of the cavity

Within the visceral layer of the tunica vaginalis, and encircling the testicle, is the *tunica albuginea*, a dense, white, fibrous capsule which is prolonged inward to form septa that divide the gland into lobules of varying size and number. Each lobule consists of a number of *semiferous tubules*, which anastomose freely and converge toward the apex of the testicle, coalescing into a number of larger straight tubes, the *tubuli recti*, which, in turn, go to make up the *rete testis*. From the rete testis spring a dozen or more *ductuli efferentes*, which, piercing the tunica

albuginea, pass backward, becoming in the globus major of the epididymis the *coni vasculosi*.

*Microscopic Structure of the Testicle* The testicle is surrounded by the tunica albuginea, a thick, unyielding, fibrous membrane which sends radiating septa into the glandular substance and forms the fibrous network of the seminiferous tubules. The septa converge toward the hilus of the testicle to form a network, the mediastinum testis (corpus Highmori).

Between these septa is the glandular tissue, which contains the greatly convoluted seminiferous tubules. The delicate supporting matrix surrounding these tubules is composed of connective tissue containing the interstitial cells of Leydig, which furnish the internal secretion of the testicle. The seminiferous tubules are lined by the basal cells of Sertoli and the cells of the spermatogenic cycle. The testicle therefore contains three types of epithelial cells: the germinal cell, the Sertoli or basal cell, and the Leydig or interstitial cell.

The tubules have relatively wide lumina with a diameter of from 200 to 300 microns. Their combined length has been variously estimated at from 250 to as high as 800 meters. One of the most complete histological studies of the testicle is that of Sappey (1889) who found the gland to contain from 200 to 300 lobules, each having from 70 to 80 cm of canals—an estimated total length of about 280 or 300 meters.

The tubules converge at the hilus of the testicle into the tubuli recti and thence into an anastomosing network called the rete testis. The rete tubules open into 12 to 15 channels, the ductuli efferentes leading into the globus major of the epididymis. The efferent ducts are lined with epithelium similar to that of the epididymal canal and are convoluted at the epididymal end but are straight at the opening into the testicle.

The walls of the seminiferous tubules consist of fibro-elastic tissue. They are lined by a several layered epithelium, the cells representing the stages of spermatogenesis: spermatogonia, primary spermatocytes, secondary spermatocytes, spermatids, and spermatozoa. It is believed that the spermatids draw nourishment from the sustentacular cells during their metamorphosis into ripe spermia, and the Sertoli cells are therefore also called *trophocytes*.

The cells represented in spermatogenesis are of great importance from a pathological viewpoint because malignant tumors of the testicle are believed to arise from one or more of these sex cells (Tumors of the

Testicle, p 451) They are also of particular importance from a physiological aspect because these cells are now known to secrete a gonadotropic hormone

The infantile testis contains none of the cells seen in spermatogenesis From early embryonic life until puberty there is little change in the primitive sex cells In the undescended testicles of cryptorchids the seminal tubules are lined with only one type of epithelium, the constituent cells representing the common ancestors of the Sertoli and sperm cells

If, at puberty, the testicles are descended into the scrotum, the spermatogenic process may normally be visualized easily in microscopic sections (Hinman) When finally the latent mother cell differentiates into spermatogonia, these become extremely active, as evidenced by the numerous mitotic figures Certain of these cells become spermatocytes, which apparently lose the power of rapid division but gain in growth and energy During growth there are nuclear changes, after which the cell becomes finally mature At this stage it rapidly divides twice These are called the maturity divisions In this division the chromosomes are reduced to one half their original number From these the spermatoids and adult spermatozoa arise

The interstitial cells have been regarded popularly as the source of the internal secretion of the testicle, but definite proof of this is still wanting These cells are found, singly or in groups, in the connective tissue between the seminiferous tubules, in close contact with the blood vessels They make their appearance when the embryo is 45 mm long and by the fifth month of fetal life are very numerous At birth the interstitial tissue between the tubules is very abundant, and lutein and lipid granules are found in considerable amounts within the cells This abundance decreases with growth and at puberty the tubules will be found, on cross section, to lie in very close approximation After puberty, when active spermatogenesis begins, the interstitial cells are filled with lipid material In addition they contain crystalloids, granules, and pigments

In the testicle of the human, the interstitial cells may vary considerably in number in different adults Teem, in the examination of more than 500 testes and prostates, found that the interstitial cells reach their average maximum number between the ages of 10 and 19 years and then gradually diminish The size of the individual cell, however increases after the fortieth year, as do also their granularity and pigment

The differentiation between these cells and those of the ordinary connective tissue is not difficult, as the nuclei are poor in chromatin and seldom show distinct nucleoli, while the fact that such vital stains as trypan blue will not take when applied to them also aids in distinguishing them under the microscope. The cells are readily recognizable under normal circumstances by staining with hematoxylin and eosin.

**The Epididymis** The epididymis though generally referred to as a separate body, is actually part of the testicle, impinging upon its posterior border. It is a long, narrow structure, originating at the apex of the gland at the point where the ductuli efferentes pierce the tunica albuginea. It consists of three sections the *globus major* or head the *corpus* or body and the *globus minor*, or tail.

The ductuli efferentes as has already been described become the wedge shaped con. vasculosi which go to form the globus major of the epididymis—that is the section contiguous to the top of the testicle. The body of the epididymis which is separated from the testicle proper by the tunica vaginalis is formed by the convoluted canal into which the con. vasculosi empty. Its lower point of union with the testicle is termed the globus minor and from this point it continues as the vas deferens. The most marked characteristics of the epididymal canal are its great length (15 to 20 feet) and its extreme tortuosity.

The epididymis is united to the testicle at three points by double ply folds of serous membrane that is actually but a continuation over the epididymis of the tunica vaginalis visceral layer. *Ligamentum epididymis superioris* is the name applied to the globus major fold between the two leaves of which pass the ductuli efferentes. At the body of the epididymis a space termed the *saccus epididymis* is enclosed by a double fold which constitutes the second attachment. The caudal end is attached by the *ligamentum epididymis inferioris*.

**The Blood Vessels of the Testicle and Epididymis** *Arteries* The principal artery of the testicle is the *internal spermatic* which arises from the aorta just below the renal arteries sends a branch to the ureter and passes with the spermatic cord through the inguinal canal to the testicle on the medial side of the body of the epididymis. A small branch also goes to the globus major. The *deferential artery*, a branch of the superior vesical is in close contact with the vas deferens until it reaches the epididymis of which it supplies the body and tail. The *cremasteric artery*, a branch of the deep epigastric runs in the external sheath of the cord of the lower pole of the testicle and epididymis. Within the

mediastinum of the testicle the arteries break up into branches which follow the septa and form a capillary plexus about the seminiferous tubules

It has been shown that, in every case, there is an anastomosis between the three arteries. Theoretically, sufficient blood supply to the testicle should be maintained if any two of these vessels are sacrificed. It has been observed, however, that severance of the spermatic artery in operations for cryptorchidism will cause atrophy of the testicle in 85 per cent of the cases (Mixer)

**Veins** The veins run a parallel course to the arteries. The *spermatic veins* emerge from the testicle with the arteries, forming the pampiniform plexus as a part of the cord and terminating near the internal inguinal ring in a single trunk. The right spermatic vein enters the vena cava, and the left the left renal vein. These veins are provided with valves, the one at the orifice of the left sometimes being lacking. Varicocele, which consists of dilatation and tortuosity of the veins of the pampiniform plexus, usually occurs on the left side, the entry of the spermatic vein into the renal vein at a right angle and the frequent absence of the valve on this side lending themselves to such a formation.

**The Nerves** For knowledge regarding the innervation of the testicle and epididymis we are greatly indebted to the very careful studies of G. A. G. Mitchell, of Aberdeen University.

The testicle and epididymis receive their innervation from three groups of nerves: (1) a *superior* group, from the intermesenteric nerves and renal plexus, (2) an *intermediate* group, from the superior hypogastric plexus or the upper end of the hypogastric nerve, (3) an *inferior* group, from the inferior hypogastric plexus.

(1) *The superior spermatic group* This usually consists of two (sometimes three) nerves. The *outer* nerve usually arises by a few rootlets from about the middle and lower parts of the renal plexus, the rootlets soon coalescing to form a single nerve which converges toward the spermatic artery. It sometimes splits into two or three branches as it passes downward, and it meets the spermatic artery at a variable distance from its origin, depending on the level of origin of this vessel from the abdominal aorta. The nerve lies to the outer side of the artery, communicates by several fine branches with the other superior spermatic artery which arises from the intermesenteric group, and enters the postero-superior border of the testicle.

The *inner* nerve of the superior spermatic group usually arises by two

or three rootlets from the lower end of the outer bundles of intermesenteric nerves. On the right side the rootlets pass to the inferior vena cava and on both sides they soon coalesce to form one or two larger nerves. As a rule only one larger nerve is so formed and this approaches the spermatic artery and occupies a course along its inner lateral aspect. In most of the specimens examined by Mitchell the nerve was observed to subdivide. The outer smaller branch was found to adhere closely to the spermatic artery and may be that blood vessel's main innervation since the larger inner branch is more readily separated from the blood vessel and moreover communicates with the spermatic nerve (or nerves) arising from the renal plexus as is evidenced by numerous fine filaments. In none of his specimens however did Mitchell observe any true spermatic plexus formation. This larger branch of the inner nerve of the superior spermatic group usually maintains its position along the spermatic artery but branches quite extensively before entering the upper part of the testicle's posterior margin.

Especial interest attaches to this superior spermatic group of nerves. Macroscopically they appear to communicate at no point with the other two groups of nerves which pass to the testicle and epididymis and seem to be the only nerves which enter the testicle directly. They are however very closely associated with the nerve supply of the kidney and with the intermesenteric nerves.

(2) *The intermediate or middle spermatic group.* Besides the superior hypogastric plexus a number of rootlets may usually be found coalescing to form the main nerve of this group. Less often this nerve arises from the upper end of the hypogastric nerve of the same side. In either case there is always an associated twig which passes to the ureter. In many of Mitchell's specimens the spermatic nerve divided into several branches some passing to the epididymis and others to the vas deferens.

The middle spermatic nerve is usually single passing downward and outward to the internal abdominal ring. Here it joins two other structures which go to make up the spermatic cord but eventually it is split up and distributed to the epididymis and the head of the vas deferens. Though the nerve passing along the vas which has its origin in the inferior hypogastric plexus communicates with this middle spermatic nerve there appears to be no relation between it and the superior spermatic nerves. The localization of this nerve to the epididymis would seem to be significant.

(3) *The inferior spermatic group.* The loop of nerves which often

surrounds the lower end of the ureter is the most common point of origin of the inferior spermatic group, but it may also spring directly from the inferior hypogastric plexus. From both the periureteral nerve group and that aspect of the inferior hypogastric plexus which is nearest to it, fine branch fibers extend in a fan shaped distribution to the vas deferens. Of these fibers one is likely to be larger than the others and more widely distributed. This chief nerve commonly arises from the anterior part of the parent loop or from the antero superior section of the inferior hypogastric plexus. Though such a nerve can be traced as far as the epididymis, and can be shown to contribute to its innervation, earlier in its course it accompanies the vas deferens and supplies that organ by numerous fine filaments. It may, however, be very easily dissected free from the vas, showing that the relation is not a close or important one. This main nerve of the inferior spermatic group communicates with the middle spermatic nerve, but has not been demonstrated to have a connection with the superior spermatic group.

**The Lymphatics** The lymphatics of the testicle and epididymis unite to form five or six large stems which pass upward in the spermatic cord to terminate in the lower lumbar nodes.

The testicle, epididymis, vas deferens, and tunica vaginalis have no connection whatever with the inguinal lymph nodes. The primary lymph zones of these structures have been anatomically demonstrated to lie in the neighborhood of their embryological origin. The testicle is originally an intra abdominal organ situated just below the kidneys and even though it later descends into the scrotum, it retains the connections acquired during the early stages of development. The pre aortic lymph nodes therefore are the primary nodes into which the testicular lymphatics drain.

The lymphatics of the testicle are of great surgical importance and a knowledge of the facts is essential to the correct diagnosis and treatment of testicular diseases.

**The Spermatic Cord** The spermatic cord is the pedicle of the testicle, and serves to support it in the scrotum and to convey the blood and lymph vessels, nerves, and the vas deferens. It extends from the internal abdominal ring through the inguinal canal into the scrotum, terminating at the posterior part of the testicle. It is made up of the vas deferens, the blood vessels, lymphatics, and nerves of the testicle and epididymis, the coverings of the testicle, and the connective tissue. Its topography is of great importance to the surgeon.

*Supports of the Testicle* The manner in which the normally descended testicle is supported and maintained in position is of particular interest to surgeons faced with the problem of fixing an aberrant testicle in its normal position in the scrotum, because such an operation can only be successful if approximately normal conditions can be established.

When the abdomen has been opened by an extraperitoneal approach for a procedure upon the ureter or iliac vessels, it is possible to investigate these supports. Such an investigation was made by Dennis Browne, who dissected the entire side of the abdomen in the cadaver, leaving the muscles on the outer side of the cleft made by the extraperitoneal incision, and the spermatic vessels, ureter, and kidney on the inner side. The cord was then freed from the opened inguinal canal, and at the point where it joined the main mass of abdominal contents the peritoneum was exposed by pulling away from it the spermatic vessels and their accompanying tissues. The true peritoneum was then dissected away leaving eventually a layer of fibrous tissue which is apparently continuous around the whole extent of the abdominal cavity, ensheathing the kidney above and receiving the ureter and spermatic vessels below. It was found that at the internal ring a prolongation of the fibers of this tissue accompanies the spermatic vessels into the inguinal canal down to the testicle. It is this fan shaped prolongation of the fibrous-tissue layer which normally takes the weight of the testicle, so that it does not come upon the relatively weak and easily stretched blood vessels and vas deferens when the suspensory muscles are relaxed.

Browne's investigations indicate that the customary way of differentiating between direct and indirect hernia—that the deep epigastric vessels constitute a dividing structure between them—is incorrect, because unsupported blood vessels have not the tenseness and rigidity necessary to withstand the strain which assigning them this function implies. Actually, the structure which forms the boundary between oblique and direct inguinal hernia is another band of fibrous tissue which defines the median half of the internal abdominal ring. "Its fibers are usually arranged as several sharp-edged crescentic folds blending behind with the sheath of the iliac vessels and in front with the general extraperitoneal fibrous tissue. In its shelter run the deep epigastric vessels, and once it has been divided it will be found that these vessels are so slack that they can be moved with ease downward and inward to the level of the external ring." In cases of ectopic testicle division of this fibrous structure, resulting in straightening of the vessels, will



usually permit the testis to be embedded within the scrotum, with its blood supply unimpaired.

**Growth of the Testicle.** Until the age of puberty the testicle remains very small. It then undergoes a period of very rapid development, except in those cases where its descent has been arrested or where varicocele has developed before puberty.

**Morphological Rests.** Attached to the testicle proper and to the globus major of the epididymis are two small bodies known as the *hydatid of Morgagni* and the *organ of Giralès (paradidymis)*.

In many individuals the hydatid of Morgagni is absent. It is a pedunculated, pear-shaped sac, from  $\frac{1}{8}$  to  $\frac{1}{2}$  inch long, its free extremity dilated and containing a colorless fluid. It is situated near the globus major of the epididymis, and is the remnant of the blind end of the wolffian duct.

The organ of Giralès is the remains of the lower group of mesonephric tubules, the progenitalis. When present, it will be found above the lowest portion of the spermatic cord, immediately over the head of the epididymis. It consists of some convoluted tubules, and looks like an irregular patch perhaps  $\frac{1}{2}$  inch in diameter.

These structures are of interest chiefly because they occasionally give rise to cystic tumors or to spermatocele.

### C. ANOMALIES

#### 1. *Anomalies of the Scrotum*

##### *Bilobate Formation*

Arrest of fetal development may prevent union of the lateral halves of the scrotum along the line of the median raphe, resulting in the formation of a separate pouch for each testicle. In individuals presenting this bifid anomaly hypospadias is almost always present also. An exceptional case was reported by MacKenzie, wherein the scrotum was completely cleft but no other malformation was apparent. The patient had reached the age of 54 years when, because of the relaxed muscle fibers which made the two scrotal pouches very long and pendulous, he first found his condition annoying. He therefore tied them in a single knot across the dorsum of the penis. The edema which quickly followed made it impossible to untie the knot, and the man came under observation with a gangrenous condition of both sides which only complete castration could alleviate.

*Congenital Cysts, Canals, and Tumors of the Scrotal Raphe*

Although these anomalies are rare, scattered reports in the literature indicate that they are encountered often enough to merit their inclusion among the anomalies that may be observed in the human scrotum

Congenital cysts and canals have been discussed under Congenital Cysts and Canals of the Penoscrotoperineal Raphe (p 240) Neff, of the University of Virginia, in 1936 described several cysts of the penile raphe and canals at the penoscrotal junction The latter should be ranked as scrotal anomalies rather than malformations of the penis and urethra, though the scrotal canals are undoubtedly of the same general type as the accessory urethras mentioned on page 626

*2 Anomalies of the Testicle and Epididymis**Anorchidism Monorchidism Synorchidism Polyorchidism*

Anomalies of the testicle, apart from those of position, are rare Congenital absence of both testicles (anorchidism) hardly ever occurs The development of only one testicle (monorchidism) is also rare, although several verified cases have been reported Fusion of the testicles (synorchidism) occurs intra abdominally, and has only been discovered at operation or autopsy Supernumerary testicles (polyorchidism) is frequently diagnosed, but rarely occurs The supposedly extra testicle is usually an encysted hydrocele, or, rarely, a partly divided gland A few actual cases have been reported, however, by Turner, Marsh, Schleimer, and others

*Cryptorchidism Ectopia of the Testicle*

Congenital malposition of the testicles is common Anomalies of position are of two types (1) retention of the testicle at some point in the course of its normal descent (cryptorchidism), and (2) displacement of the gland from its normal course of descent (ectopia testis)

**Cryptorchidism (Retention).** Normally, both testicles are descended into the scrotum at birth During the intrauterine period, one or both glands may, however, be arrested at some point in the line of normal descent The testicle may be retained entirely within the abdominal cavity, or it may be arrested between the internal and external inguinal rings, or retained in the upper part of the scrotum

**Incidence** Non descent or partial descent occurs in about 4 per cent of boys under 15 years of age The condition is more frequently uni

lateral, and is seen oftener on the right side than on the left. Bilateral cryptorchidism is fairly common.

**Ectopia (Displacement)** Sometimes the testicle descends as far as the outlet of the inguinal canal and thence deviates to some abnormal position, most commonly the perineum (ectopia perinealis). These aberrant glands have also been found at the penoscrotal junction (ectopia penalis), in Scarpa's triangle (ectopia cruralis), and toward the anterior superior spine of the ilium on the superficial surface of the aponeurosis

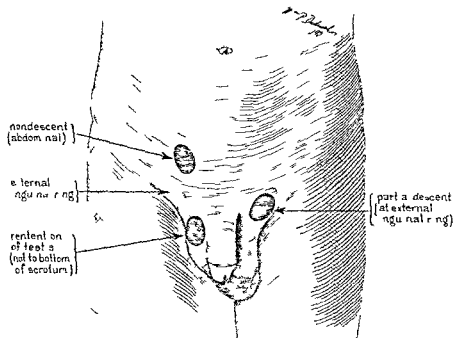


FIG. 78. Various types of undescended testes. A testis may be retained within the abdominal cavity or arrested between the internal and external inguinal rings or retained in the upper part of the scrotum.

of the external oblique muscle (ectopia inguinalis interstitialis). Both testicles may descend by the same inguinal canal (ectopia transversa). Rarely, a testicle will descend into the true pelvis (ectopia pelvis). A case of ectopia pelvis is illustrated in figure 90.

**Etiology of Cryptorchidism and Ectopia** Maldevelopment of the structural route along which the testicle must descend leads to retention or displacement of the gland, but authors differ widely regarding the details of the many possible defects which might produce, or help to produce, these anomalous conditions. Possible contributory factors

are maldevelopment of the scrotum and its investing pouches, or of the cremaster muscle, gubernaculum, or inguinal fold (Supports of the Testicle, p 374) Certain fibers of the gubernaculum may exert unusual tension upon the testicle in such a way as to divert it from its normal line of descent, and the advance of a hernia may push it into an anomalous position In cases of arrested descent, hormonal deficiencies also appear to play a part

**Pathology** As a rule, cryptorchid and ectopic testicles in adults are atrophic, and spermatogenesis is absent The degenerative changes in undescended testicles become increasingly recognizable after puberty Dissolution and atrophy of the seminiferous tubules gradually take place, but the interstitial cells of Leydig are apparently not greatly influenced by the abnormal position

Abdominal retention of both testicles is frequently associated with maldevelopment elsewhere in the genital tract

**Complications of Cryptorchidism and Ectopia** In addition to testicular atrophy, sterility, and, sometimes, imperfect attainment of the secondary sex characteristics, there are certain other complications to which the retained or displaced testicle is prone

The abdominally retained testicle is far more liable to *torsion* and the partially descended testicle to *trauma*, than is the fully descended gland

Most observers agree that the abnormally situated testicle is also more susceptible to *malignant degeneration* than is the normally placed organ

**Hernia** is a very common accompaniment of imperfectly descended testicles In the normal descent of the testicle into the scrotum it is accompanied by a tube of peritoneum, the processus vaginalis, the upper opening of which is closed after descent is complete If, however, the testicle's descent is arrested, the processus vaginalis remains patent This may also occur with a normally descended but undersized gland, so that not infrequently one will find a more or less defective testicle in its normal position and accompanied by prolapse of certain of the abdominal viscera into the processus The peritoneal process associated with an undescended testicle often has a larger lumen than is found when descent has taken place normally, a fact which may account for the greater frequency of torsion of the spermatic cord under these circumstances

Abdominal and inguinal retention favor the early development of a hernial protrusion, while the testicle lying just below the superficial abdominal ring, high in the scrotum, as a rule does not so soon have an

accompanying hernia. It must always be borne in mind, however, that persons with a partially descended testicle may exhibit a hernia at any age.

*Inguinal hydrocele* is very infrequently observed surrounding an undescended testicle.

*Associated nervous disorders* are common. Boys with this defect often become neurotic, especially if they are not relieved before puberty. Adults sometimes fear lack of sexual power and the ability to reproduce, and may become depressed and morose on this account. Reduction of the testicle usually relieves the neurosis.

**Diagnosis** Diagnosis depends upon the findings of physical examination. Failure of the testicle to descend causes that side of the scrotum which has not received its normal content to appear shriveled and often to remain noticeably undeveloped. When both testes fail to descend, the appearance of the scrotum will simulate the labia majora of the female, and there may be some difficulty in determining the sex of the individual.

The palpable ectopic testis is easily diagnosed. If the testicle is intra-abdominal, and cannot be palpated, the diagnosis can be made only by operation.

**Treatment** Non-descent or partial descent of the testes at birth is common. If the glands have not fully descended by the end of the first year, it is customary to consider the condition as abnormal. Many of these testes will descend spontaneously later—usually at or shortly after puberty, but frequently not until the sixteenth or seventeenth year. True undescended and ectopic testes cannot descend because of mechanical factors present and therefore require surgery.

The longer the testicle remains in its abnormal position the greater will be the atrophy and degeneration of the seminiferous tubules. If the testicle has not descended spontaneously at a fairly early age, operation should be done—not only so that the gland may develop normally, but because undescended testicles are more liable than normally situated glands to suffer trauma, torsion, or malignant degeneration.

**Hormonal Therapy** Attempting to bring undescended testes into their proper position in the scrotum by the use of gonadotropic hormones derived from the anterior lobe of the pituitary gland and similarly acting water soluble substances derived from the urine of pregnant women has many enthusiastic advocates.

It is our belief that endocrine therapy with gonadotropic hormones is

not only valueless in effecting descent of a testis but, in larger doses, is definitely harmful to undescended testes. True undescended and ectopic testes, which are fixed in their abnormal position, will not descend into the scrotum with hormonal treatment, but require operation for their correction. Testes that do descend following injection are the type of abnormally situated glands which invariably will descend spontaneously—usually about the time of puberty. That this point of view is becoming more common among those who have utilized this form of therapy is evident from the literature.

Of particular interest, in this regard are the recent experiments of Eisenstaedt Appel, and Fraenkel on rats. In these, the experimental animals showed a characteristic response to hormonal treatment when the testes had been made cryptorchid. The gross appearance of these testes corresponded closely to that of human undescended testes which had received larger dosage of hormone (approximately 6 000 R U) and which subsequently required operation to overcome a mechanical cause for their failure to descend. The most striking changes were in the capsule and the seminiferous tubules. Dense fibrous adhesions were present between the visceral and parietal layers of the tunica vaginalis and there was marked thickening of the tunica albuginea—changes which were not observed in the cryptorchid testes of uninjected control animals. Changes in the tubular epithelium consisted in a decrease in the number of the sex elements and failure of their development. There was complete absence of spermatids and mature sperms and the tubules were shrunken and atrophic and filled with Sertoli cells and spermatogonia. Occasional partially or completely hyalinized tubules were observed throughout the sections. Similar but much less marked changes were seen in the untreated cryptorchid testes used as controls. The tubules of these contained many spermatogonia and spermatocytes and, occasionally mature sperms with no evidence of hyalinization of the tubules. The interstitial tissue in the cryptorchid testes in both the treated and control animals was increased in amount. Often there was considerable edema of the interstitial tissue. These changes were most marked in the injected animals. It is the opinion of these authors that the surgical correction of undescended testes after hormonal treatment is not facilitated as claimed by many, but is rendered more difficult due to the increased number and thickness of adhesions.

*Surgical Treatment* The surgical correction of undescended and ectopic testicles is considered under Operative Treatment of Cryptorchidism and Ectopic Testicle (p 487)

*Hermaphroditism and Pseudohermaphroditism*

**Hermaphroditism** A true hermaphrodite is one who possesses the gonads and external genitalia of both sexes and is able to function as either male or female. No such individual has been proven to have existed.

*Hermaphroditismus verus* in the human is of three types. There may be an ovary on one side and a testis on the other (*hermaphroditismus lateralis*), or an ovotestis on one side, with either an ovary or a testis on the other (*hermaphroditismus unilateralis*), or an ovary and a testis on each side (*hermaphroditismus bilateralis*).

Hermaphroditism in man is exceedingly rare. In his excellent treatise published in 1937, H. H. Young has listed the 20 cases of true hermaphroditism accepted as proven microscopically. He found ovotestis present in all but two of these. His classification of these cases is as follows:

*Hermaphroditismus lateralis* 3 cases (including 1 of Young's own)

*Hermaphroditismus unilateralis* 9 cases (an ovotestis on one side with an ovary on the other 5, an ovotestis on one side with a testis on the other 4)

*Hermaphroditismus bilateralis* 6 cases

Young's own case of *hermaphroditismus lateralis* is particularly interesting in that the 18 year old patient was masculine in every external aspect, with strong male tendencies and sexual emotions, yet the ovary showed complete functional development, ovulation having evidently gone on for some time. At operation for left undescended testicle, a uterus, tube, and functioning normal ovary were discovered in the abdomen. The testicle on the opposite side was in the scrotum. Panhysterectomy and a successful plastic operation for hypospadiac penis resulted in a normal sexual life for this patient.

In a case reported by Kwartin and Hyams (1927) there was a short penis, an empty scrotum, similar in appearance to that in any case of cryptorchidism, and a mass below the right external inguinal ring attached to the base of the internal aspect of the scrotum by a fascial tendinous cord. On section this mass proved to be an ovotestis, its upper part being composed of atrophic ovarian tissue and the lower part, which was separated from the upper by a firm fibrous band, containing cellular structures similar to those found in cryptorchid testicles. On the opposite side was an ovary.

**Pseudohermaphroditism** A pseudohermaphrodite is one in whom the gonads of but one sex are present, but there are abnormalities of the ex-

ternal genitalia which make the true sex of the individual doubtful. The external genitals usually resemble those of the opposite sex and are frequently rudimentary. The duct system may be mixed or bisexual, and more or less atrophic, and there is an amazing complexity in the distribution of the secondary sex characteristics. In fact, any definition and classification of pseudohermaphroditism must be loosely interpreted, so numerous and varied are the types of deviation from the normal. The difficulties of the physician who is called upon to decide the sex of such an individual are apparent. The sex is often erroneously interpreted at birth and children are brought up as boys (or girls) when actually they are of the opposite sex. Pseudohermaphroditism is not uncommon, and occurs once in 1000 persons (Young).

In an interesting case reported by Cullen, the patient's general appearance inclined to the masculine and an organ suggesting a penis was present. The urethra, however, was distinctly of the female type and there was a vagina in normal position, into which the finger could enter for  $1\frac{1}{2}$  inches although it ended in a blind pocket with no evidence of a cervix uteri. Operation upon a right inguinal hernia showed the sac to contain a testicle and a portion of the epididymis, while careful search of the abdomen failed to reveal any trace of uterus, tubes, or ovaries. On the left side a testicle could be clearly made out in the upper part of the inguinal canal. Histological examination of the testicle showed some minor changes. The gland epithelium was swollen, the cells closely suggesting the large squamous epithelial type. There was no evidence of spermatozoa. The epididymis was but little altered.

The 10 year old patient, whose case was reported by Quinby, was raised as a boy because of the male type of genitalia and predominating male secondary characteristics. The services of the surgeon were sought on account of hypospadias and "undescended testicles." There was no evidence of a vagina. Search for the supposed testicles revealed no trace of a spermatic cord in the inguinal canal, and in the abdomen was found an infantile uterus with attached tubes and ovaries of normal appearance. Therefore, this individual was of the female sex despite greatly predominating male secondary characteristics, which were undoubtedly influenced by the adrenal hypertrophy that was demonstrated.

In his monograph (1936) Young has reported a most interesting group of 17 cases, 10 of the male and 7 of the female type, with remarkable variety in the secondary characteristics. In one case the patient had



been reared as a girl until 20 years of age, when, doubting "her" sex, "she" assumed male attire and submitted to examination. This revealed a hypospadiac penis, partially descended testes, cleft scrotum, a pseudo vulva, and a female-type urethra. There were nocturnal erections and emissions, and the emotions were entirely masculine. Numerous operations to cure the abnormalities were successful, and the patient married his hospital nurse and had a normal sexual life. In another case the individual was reared as a male until 13 years old. Examination at that time showed a well developed hypospadiac penis, fully descended testes, an abnormal left epididymis, male type chest and pelvis, and female labia, urethra, and vagina. At operation for removal of the vagina, tissue of a fallopian tube was found attached to the upper end of the vagina, and was also removed. The left testicle and epididymis were abnormal and there was no vas deferens.

In our own case, that of a 17 year-old male who had been brought up as a girl until 4 years of age, the abnormalities were confined to the external genitalia. The penis was small and bound down to the scrotum, the testicles undescended and palpable in the inguinal canal, and at the penoscrotal junction was a cleft in the tissue giving the appearance of labia majora. In this cleft was the urinary meatus and just below it a small vagina which admitted a catheter for a distance of about 3 cm. The prostate was of normal size. In every other way the boy was masculine in appearance and in temperament. The hypospadiac condition was corrected by a three stage plastic operation (Figs 62 to 68), the vagina removed, and bilateral orchidopexy done.

**Etiology** The embryological development of the testicle and ovary offers ample opportunity for the complex maldevelopment resulting in the various types of hermaphroditic anomalies. A definite explanation of this unfortunate occurrence is, however, still forthcoming. Among the various possible etiological factors that have been suggested are disorders originating in the gametes, disturbances in the chromosome formula, endocrine gland dysfunction during embryological differentiation, maldevelopment of the interstitial cells of the testicle and ovary, resulting in incomplete development of the internal and external genitalia, developmental defects of the urogenital sinus, producing multiform abnormalities of the external genitalia.

**Diagnosis** There is only one way in which true hermaphroditism can be accurately determined, and that is by operative investigation, to discover whether a testicle and an ovary are present in the one person.

Exploratory operation is also usually necessary in pseudohermaphrodisism, to ascertain the true sex of the individual

**Treatment** Treatment of these conditions has been, for the most part, unsatisfactory. In true hermaphrodisism, removal of the ovary, if the secondary characteristics are predominantly male, or removal of the testicle, if they are predominantly female, will result in a certain degree of benefit to the patient.

Treatment of pseudohermaphrodisism consists primarily in correction of the external physical defects. So many are the forms which this anomaly may assume that no general rules can be laid down. Each case requires careful individual study, with treatment adapted to the individual findings.

### *Anomalies of the Epididymis*

The epididymis may not only be malformed in a variety of ways, but it may be abnormally situated in the scrotum in relation to its testicle. Sometimes there is absence of the epididymis; the ductuli efferentes anastomosing directly to form the vas. The epididymis may be so large, in relation to the peritoneal tube through which it must descend to reach the scrotum, as to render this descent impossible. Other cases have been recorded in which the testicle proper was arrested in the inguinal canal, although the vas deferens and epididymis were descended and palpable outside the canal. It should be emphasized in this connection that the vessels conveying the blood supply of the testicle are entirely separate from those supplying the epididymis and vas deferens.

## D. PHYSIOLOGY

### *1. Physiology of the Scrotum*

The scrotum not only provides a receptacle and protective covering for the testicles, but acts as a thermoregulator for these glands.

That such thermoregulation is necessary for spermatogenesis was established by a series of experiments carried out at the University of Chicago by Carl R. Moore and his associates in 1924. It was found that a normally functioning testicle of an adult guinea pig lost practically all its germinal epithelium when the testicle was elevated from the scrotum into the abdomen. When examined after the lapse of two to three weeks, the tubules were found to be shrunken and vacuolated and their canals empty. A single basal row of nuclei were unaffected, which were assumed to be Sertoli elements. Spermatogenesis from the transplanted

testicle ceased entirely and was not resumed as long as the gland was kept in the abdomen, but so soon as the testicle was returned to the scrotum, even when epithelial degeneration had taken place, spermatogenesis was immediately resumed, so that live spermatozoa could shortly be demonstrated. It was found that the factor responsible for this degeneration of the transplanted testicle was the higher temperature of the abdomen, which in the guinea pig is  $2^{\circ}$  to  $3^{\circ}\text{C}$  higher than that within the scrotal sac. Other investigators reported a similar difference between the scrotal and abdominal temperatures of the rabbit. Transplantations were carried out on a large number of experimental animals, with similar results.

That the scrotum protects the spermatozoa after they have been fully matured and stored in the epididymis was proved by another worker in Moore's laboratory, Heller. Working with guinea pigs and rats, he found that if the epididymis were isolated, but left in the scrotum, the spermatozoa remained active for as long as 30 days. When the gland was altogether removed from the animal's body, but was retained in the scrotum while immersed in saline solution, the spermatozoa were kept alive for as long as 23 days. Without the protection of the scrotum the sperm was lost within 13 to 14 days.

In later experiments Moore and his co-workers confirmed their earlier work, and in Europe, Harrenstein, of Holland, and Knaus, of Germany, extended their findings to human subjects, ascertaining the same variations of temperature within and without the scrotum.

The structure of the scrotum—its thin walls, lack of subcutaneous fat, rich supply of sweat glands, and power of relaxation and contraction—is peculiarly adapted to this delicate function of regulating the environmental temperature of the testicles. That such a function is essential for sperm cell formation is shown by cryptorchids, in whom spermatogenesis is diminished or absent, due, it is now believed, to the elevated temperature of the abnormally situated testicles.

## 2 *Physiology of the Testicle*

**Dual Function of the Testicle** The testicle has a dual function (1) the production of spermatozoa, and the secretion by its tubules of a fluid which nourishes the spermatozoa and serves as a medium for their transportation down the genital tract, (2) the production of an internal secretion which, in conjunction with the pituitary endocrines, controls the growth of the accessory sex organs (epididymes, seminal vesicles, pros-

tate, and bulbo-urethral glands) The exact nature of this endocrine is not known It is unrelated to spermatogenesis and an azoospermatic undescended testicle produces it as readily as a normally situated gland

Berthold (1849) through his transplantation studies on capons first put forth the idea that the testis secreted into the blood stream some substance that was responsible for preserving the male sex characteristics Only within comparatively late years, however, has a dual function of the testicle been demonstrated, and the fact that these functions reside in different portions of the gland, so that it is possible to dissect away either part, leaving the other capable of carrying on its separate activity, is a still later discovery Real progress on the biochemistry of the male sex hormones is a product of the last decade Although the entire subject is still in the experimental stage, to the urologist the demonstration of a characteristic male sex hormone has opened up avenues leading to greater precision of diagnosis and an immense increase in the possibilities of treatment

**Types of Cells Concerned in Testicular Function** Three types of epithelial cells are concerned in these functions of the male gland (1) the spermatogenic cells, which line the seminiferous tubules (2) the basal or Sertoli cells, which are situated at intervals on the basement membrane of the tubules, between the spermatogenic cells, (3) the interstitial or Leydig cells, which are found in the connective tissue between the seminiferous tubules (*Microscopic Structure of the Testicle*, p 368)

**Source of the Internal Secretion** The popular belief that the sexual endocrine is produced solely by the interstitial cells of the testicle still awaits proof These cells were first described as distinct from the spermatogenic cells in 1850 by Leydig, who believed them to be a type of connective tissue cell which supplied nutriment to the spermatogenic cells—a view generally accepted until the beginning of the present century

In 1903, Ancel and Bouin showed that the tubular and interstitial portions of the testicle had different functions, and attempted to prove that it was the interstitial portion which produced an internal secretion upon which the development of the male sex characteristics depend They had reached these conclusions through investigations which indicated that although abdominal retention of the testicle or ligation of the vas rendered the individual incapable of spermatogenesis, so long as the interstitial portion of the gland remained intact the secondary sex characteristics were not interfered with

Much work by later investigators has not yet definitely determined whether the sexual endocrine is produced solely by the interstitial cells or by the Sertoli cells. The inference that the Leydig cells are the source of the male hormone is made from observations on the cryptorchid testis, the testis treated by roentgen ray, and atrophic and hypertrophied testes.

*In the undescended testicles of cryptorchids* the seminiferous tubules are atrophic, and are lined with only one type of epithelium, the component cells representing the common ancestors of the Sertoli and sperm cells. The interstitial cells, however, are normal or hypertrophied. Although the undescended testicle is incapable of spermatogenesis as a rule, the secondary sex characteristics develop normally in most bilateral cryptorchids. Transplantation of the testicles from the scrotum to the abdominal cavity in animals (experimental cryptorchidism) has been shown to result in extreme modification of the germinal epithelium, but the interstitial cells retain their characteristic appearance and the masculine sex qualities are maintained. The Sertoli cells also remain unaffected.

*In the testis treated with x ray therapy* the Sertoli cells and interstitial cells of Leydig remain normal, although the Sertoli cells may be distended with fat. The most radiosensitive cells are the spermatogonads. The fact that the Sertoli and interstitial cells remained uninjured after high voltage x ray dosage, while the same exposures caused degeneration of the tubular components, was noted some years ago by Max Thorek and others. Examination of the Leydig cells in testicles showing extreme x ray injury and degeneration of other cellular structures revealed that, far from suffering harm, the interstitial cellular structure had been actually stimulated and benefited. In the extensive studies carried out by Lower and his associates at the Cleveland Clinic, it was found that decided alterations in glandular function followed exposures of the testicles to radium or roentgen radiation, and that these findings were strikingly similar to those observed in glands which had been transplanted from the scrotum to the abdomen. There was degeneration of the spermatogenic elements but an increase in interstitial tissue and in the number of the Leydig cells. It was further noted that whereas very weak dosage was sufficient to bring about tubular degeneration and azoospermia, it was only extremely high dosage which would destroy both the Sertoli and interstitial cells. Moreover, destruction of the tubules alone activated the Leydig cells to produce greater amounts of male hormone. As this excessive production of the male hormone is now

believed to induce prostatic hypertrophy, we have here an explanation for the tendency toward prostatic hypertrophy as age begins to lessen the sperm producing powers of the testicle

*In the atrophic testis* the Sertoli cells are found to be constantly present, and this fact has led to the suggestion that these may be the hormone producing cells. It is possible that both the Leydig and Sertoli cells have an internal secretion

**The Testicular Hormones** It is now believed that there are two male hormones (1) the male sex hormone (androtin), (2) a substance which inhibits the activity of the pituitary gland (inhibin). Under normal conditions these two hormones supplement each other

*Androtin* is a lipid soluble substance believed to be derived from the interstitial cells, and acts as a sex stimulant. It is the comb growth promoting substance of male urine, and is chemically and physiologically comparable to ovarian theelin. It is produced only upon stimulation of a gonadotropic hormone formed by the anterior lobe of the pituitary gland. Following hypophysectomy there is an immediate decrease in the size and weight of the testicle, as well as in its spermatogenic ability. Androtin is necessary to maintain the prostate in the normal state, but it is capable of producing hypertrophy if an excessive amount is produced. It is now a well recognized fact that the pituitary gland can stimulate the testes to the production of enough androtin to cause hypertrophy of the prostate in rats

*Inhibin* (contruin), the second testicular hormone, is an hypothetical water soluble substance supposedly secreted by the germinal cells of the seminiferous tubules. It is believed to inhibit the anterior pituitary action on the accessory male reproductive organs. The absence or reduction of inhibin leads to excessive secretion of the pituitary gonadotropic hormone, which stimulates the secretion of androtin sufficiently to produce hypertrophy of the prostate. From these facts Lower, Engel and McCullagh, of the Cleveland Clinic have postulated the following theory for the development of prostatic hypertrophy with the advance of age. Normally the spermatogenic cells secrete enough inhibin to prevent excessive activity of the pituitary. With degenerative changes, or decreased spermatogenic function due to the advance of age there is a gradual reduction in the amount of inhibin. With the restraint removed, the pituitary becomes hyperactive and stimulates the interstitial cells to produce an excess of androtin, which in turn produces prostatic hypertrophy

Androtin, the male sex hormone, is present in testes and also in the urine of males of all ages except the very young. Womack and Koch found no comb growth promoting hormone in urine from boys under 10 years of age. Normally, it is produced continuously and is eliminated through the kidneys. There is no storage of the endocrine anywhere in the body.

The various tests for the quantitative detection of the male hormone are based on the effects produced by the injection of a source of the hormone into a castrated animal. Rats, guinea pigs, and capons have been used extensively in tests of hormonal activity. Caponized cocks are particularly good subjects for the demonstration of the male hormone.

As far back as 1849 Berthold showed that the well known effects of castration could be prevented by grafting the testes elsewhere in the bird's body. As a result of these pioneer transplantation studies the testicle became the first organ shown to possess an endocrine function. The delayed discovery of a method of extracting the male hormone from testis tissue, as compared with the extraction of hormones from other endocrine glands, can probably be attributed largely to the very low concentration of the hormone in the testis tissue. The first investigator to study the effects of active testicular extracts by the cockscomb method was Pezard (1918), who observed that extract from cryptorchid testes produced full comb growth in a capon. McGee (1927) accomplished the first successful method of extraction and concentration of the male sex hormone from testicular tissue. Moore, McGee, Price and Gallagher (1928-1929) proposed a new test based upon cytological changes in the accessory reproductive organs and the secretions of the seminal vesicles and prostate.

A quantitative test for the male hormone was devised by Koch and Gallagher in 1930. This was based on the minimum dose necessary to produce a detectable comb growth in 5 days.

Since the development of the methods of extraction and assay by McGee, Gallagher, and Koch, and the subsequent finding of the male sex hormone in the urine, there has been amazing progress. In 1931, Butenandt isolated the male hormone in crystalline form from human urine, and to this the name *androsterone* was given. In 1934, Ruzicka synthesized androsterone from cholesterol. This was the first artificial production of a sex hormone.

In 1935, David, Dingemans, Freud, and Laqueur, of Amsterdam, isolated in crystalline form from bull testis tissue itself a very potent

substance which possessed marked androgenic properties. To this has been given the name *testosterone*. It is the only androgenic substance which has been extracted and recrystallized in a chemically pure state from testicular tissue. There is some evidence that testosterone originates in the interstitial cells of Leydig, and that another testicular hormone arises in the germinal cells of the tubules. Later in 1935 testosterone was synthesized from cholesterol by the Butenandt and Ruzicka groups.

It has been assumed by many investigators that the male hormone extracted from the urine is identical with that recovered from bull testis tissue. However, Laqueur and his associates (1931), and later investigators, have found that their chemical and experimental properties are different. Androsterone affects the prostate mainly, and testosterone affects the prostate and seminal vesicles equally. Using the capon, testosterone possesses 7 times the comb growth activity of androsterone and 21 times that of dehydroandrosterone (Day). Neither of the two androgenic hormones present in male urine—androsterone and dehydroandrosterone—has ever been recovered from extracts of testis tissue itself and their primary origin is still unknown. It is believed by some investigators that they may be only degradation products of the true sex hormone.

**Interrelation of the Testis and Other Endocrine Glands** The interrelation between the testis and the other endocrine glands, notably the pituitary and the adrenals, is very complex and not completely understood. It is well known that disturbance of one gland throws the others out of balance. The various forms of endocrine dystrophias, such as eunuchism, infantilism, senilism, gigantism, dwarfism, hermaphroditism and Frohlich's disease—are usually caused only in part by dysfunction of the internal secretion of the testis.

That there is a hormonal balance among the hypophysis, testis (or ovary), and secondary sexual organs is an established fact. The testis (ovary) functions only when stimulated by certain substances that normally are supplied by the anterior pituitary. The activity of the pituitary, on the other hand, is normally held in check by gonadal secretions, for when the testicular hormones are present in normal amounts hypophyseal activity is lowered, but when this inhibition is removed, hypophyseal activity is increased. Evans has isolated two substances from the anterior lobe: a sex stimulating (gonadotropic) hormone and a growth stimulating hormone.



*Effects of Castration* There is no proof that castration in animals necessarily damages the animal except in its breeding capacity. In man, the effects of castration, or removal of the testicular endocrine from the body, are complex. They differ according to whether castration is done before or after puberty.

Before puberty, growth is obviously more affected since the secondary sex organs are still small and ill developed. Castrated immature males at maturity show lack of development of the genital organs and secondary sex characteristics. Castration at birth leads to eunuchism. Post-pubertal castration produces less well marked changes. Deficiency of the endocrine after development of the genital organs will affect their normal activity. Spermatogenesis ceases, and degenerative changes take place in the epididymes, vasa, seminal vesicles, and prostate. In males, castration may have a considerable psychological effect.

Korenchevsky and Dennison (1935) found that experimental castration is followed by delay in the normal involution of the thymus, slight atrophy of the thyroid, enlargement of the adrenals, and the appearance of castration cells in the anterior pituitary.

Many clinical and experimental studies have established that castration leads to hypertrophy of the hypophysis, which is associated with characteristic histological changes in the anterior lobe and an increased secretion of gonadotropic hormones, as demonstrated by hypophyseal-implantation and parabiosis studies and by the increased concentration of gonadotropic substances in the urine of castrated animals.

It has also been established that hypophyseal implants or injections of the pituitary gonadotropic hormone, through stimulation of the testes, produces prostatic hypertrophy, whereas castration (in the rat) is followed by atrophy of the prostate and certain characteristic histological changes consisting of decrease in the size of the cells and marked increase in interacinar stroma. In castrated animals, neither hypophyseal implants nor injections of the pituitary gonadotropic hormone prevent the usual atrophy of the prostate and seminal vesicles. Injections of lipid extracts of androgenic substances from bulls' testes into castrated animals, however, prevent atrophy of the prostate and vesicles, and feeding of desiccated bulls' testes to normal adult male rats, or the injection of the aqueous extract, over a period of time, results in hypertrophy of the prostate and vesicles. From these and other experimental findings there has been postulated a second male substance which inhibits the activity of the anterior pituitary.

**Therapeutic Use of the Testicular Endocrine** *Testicular Grafts*  
 The clinical employment of the internal secretion of the testis awaits standardization. Although remarkable results have been reported from reliable sources, some of the most enthusiastic accounts of rejuvenation have not been substantiated.

Nearly a quarter century ago Lespinasse conceived the idea of grafting slices of human testicle, taken from a living or recently dead subject, between the layers of the rectus muscle. The transplants absorbed within a few months and the potency of the individual declined to its former state. The operation had a very limited application owing to the difficulty of procuring material for grafting. The work of Lespinasse was followed by that of other investigators including Lydston, Morris, McKenna and Voronoff.

Voronoff's enthusiastic preliminary reports on the transplantation of testicles from young animals to old and from anthropoid apes to man (1919), and his continued interest, have not been confirmed by other investigators.

Reports on testicular grafting have emanated with considerable regularity from the service of L. L. Stanley at the San Quentin prison in California. In 1931, he reported on some 6,000 testicular implants, his subjects being convicts in the prison who voluntarily submitted to the operation. Results on 50 patients who had received injections of a paste of macerated rams' testicles were published by Stanley's assistant, Louis Breck, in 1934. The results claimed were: marked improvement in symptoms such as asthenia, constipation, general debility, 75 per cent, marked sexual stimulation, 46 per cent, marked 'dynamic' effect, 81 per cent.

Jeanbrau (1928) expressed the opinion that testicular grafting is neither dangerous nor inconvenient and that it can be effectual and productive of good results (1) in surgical castrates whose testicles have been destroyed by an organic disease or surgically extirpated, (2) in the subjects of bilateral testicular atrophy following trauma or mumps, (3) in cases of premature senility, and (4) in elderly men who desire a supplementary period of physical, intellectual, or even genital activity. He emphasizes that the organs and tissues are not made young again, but merely receive a temporary stimulation, and that the bodily changes experienced after testicular grafting should not be referred to as "rejuvenation" but, rather, as "revitalization." Thorek also stressed the fact, apparent in his extensive investigations, that while no 'rejuvenation'

In popular sense of the word has ever been witnessed, yet successful testicular and ovarian transplantations have unquestionably improved both physical and psychical powers and retarded the onset of senility, particularly in women.

The literature of the last decade contains comparatively little on the subject of testicular grafting other than the reports of Voronoff and his followers. Urologists, both in Europe and America, pass over the subject almost in silence.

They have utilized the syringe method of Stanley, who recommended the injection of testicular material from animals under the fascia of the abdominal muscle. The only material easily obtainable by us was the testis of the ram. This was cut into small strips under sterile precautions and injected by means of a metal syringe and a large needle. Hospitalization was required. An occasional case resulted in necrosis and discharge of the foreign substance, but usually the material was absorbed without undue local disturbance. The results were very interesting. The patients were considerably stimulated sexually for about six months on the average. Some were reinjected but most of them lost interest when they found that the effect was transitory.

*Testicular Extracts.* There are many testicular extracts now on the market (aqueous, acetone, benzine soluble, lipo soluble, etc.). These and their clinical employment require much needed standardization. Before the use of this endocrine will be removed from the realm of therapeutic uncertainty. Because the yields of the lipoid concentrate from ram testis tissue and from human urine are entirely too low and the process prohibitive, it is necessary to rely on relatively inexpensive synthetic substitutes. Too much emphasis cannot be placed on the use of chemically pure hormones.

During the last decade the possibilities of the clinical application of testicular therapy in certain cases of prostatic hypertrophy have attracted the attention of many responsible workers in America and Europe (Hypertrophy of the Prostate, p. 840). Their researches indicate that hormone therapy may produce a definite clinical improvement in patients whose prostatism is not too far advanced, and in a very small percentage of cases there may be actual diminution in size. However, the use of glandular therapy in the treatment of prostatic hyperplasia is still in the experimental stage, and infinitely more experimental and clinical data are necessary before definite conclusions can be drawn as to the real value of such therapy. The synthetic preparations chiefly

used are testosterone propionate (perandren), androsterone, androstine, hembreol and inhibin.

The male sex hormones also have been found of clinical use in the treatment of nervous exhaustion, asthenias and severe menopausal symptoms.

It is important to remember that the administration of sex hormones does not stimulate the testis to produce hormone. On the contrary, there are grounds for believing that it definitely inhibits such internal secretion.

For many years Lowsley has been using an alcoholic extract of prostatic seminal vesicular testicular ovarian anterior pituitary and adrenal tissue as an injection in men for the improvement of sexual desire and ability and in women who have had all or a part of their ovarian tissue removed. The extract is injected subcutaneously daily for a period of 2 weeks and twice a week thereafter. The result of this treatment has been spectacular in some cases and helpful in all. It acts as a booster so that after a short period of treatment the patient in many instances resumes his former efficient state. In women suffering from hot flashes, vesical irritation and other evidences of the menopause, either artificial or induced, the condition is materially improved, but the extract must be administered at regular intervals over long periods.

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## CHAPTER XI

### INJURIES AND DISEASES OF THE SCROTUM AND SCROTAL CONTENTS

#### A INJURIES OF THE SCROTUM AND SCROTAL CONTENTS

##### *1. Injuries of the Scrotum*

###### *Wounds*

**Types of Wounds** In civil life, wounds of the scrotum are relatively infrequent. They may, however, be encountered in the form of contusions, gunshot wounds, stab wounds or lacerations.

Many observations upon wounds of the scrotum were made during the World War. War injuries are, as a rule, more extensive than those of civil life, and the surrounding structures are more likely to be involved. Moreover, as they usually occur in young adults, the necessity of conserving sexual function is especially great. The reported injuries varied from simple contusions, sometimes giving rise to a hematoma, hematocele, or traumatic orchitis, to complete destruction of the scrotum and its contents. Lesions of the urethra, herniation of the testicle and impacted foreign bodies were frequent complications.

Contusions of the scrotum are of fairly common occurrence, especially among athletes and others engaging in strenuous physical activity. They are of no great importance unless they cause hematoma.

More or less extensive wounds following attempts at emasculation are occasionally seen.

Severe lacerations, even to the tearing away of the entire scrotum, are sometimes encountered, particularly in industrial practice.

**Treatment of Scrotal Wounds** Scrotal wounds should be treated in accordance with recognized surgical principles. Of great importance are (1) thorough cleansing of the original wound and maintenance of antisepsis throughout the healing process, (2) careful examination to discover and stop all sources of hemorrhage, the avoidance of hematoma being of the utmost importance. If the skin edges are properly sutured, healing by first intention usually takes place, even where the loss of substance has been considerable.

*Palliative Treatment* Comparatively simple treatment suffices in the majority of scrotal wounds. Rest, elevation of the scrotum and cold applications will usually allay pain and prevent hematoma formation. There is no part of the body which responds more readily to palliative treatment if intelligently and promptly applied. Heat is not so often useful as cold applications, but finds its best employment in acceleration of the circulation when this is desirable—for example, in promoting the absorption of a hematoma.

*Operative Treatment* In open wounds the bleeding may be profuse, requiring careful suturing of the scrotum through all its layers.

While the regenerative properties of scrotal tissue are so great that small wounds heal with ease, in the absence of infective complications, and even large areas are at times completely restored without surgical intervention, plastic operations are usually advisable if extensive areas of tissue have been lost. If septic infection does occur, it is apt to spread quickly and slough widely, due to the looseness of the areolar scrotal tissue.

Foreign bodies should be removed immediately. This is readily accomplished if only the scrotum is involved. If the scrotal contents or the urethra are injured, they should be dealt with first. If hernia of the testicle has occurred, reduction should be attempted at the earliest moment, in order to avoid strangulation with its inevitable sequela—sloughing or gangrene.

### *Hematoma and Hematocele*

As both hematoma and hematocele are, more often than not, traumatic in origin, they may be considered under scrotal injuries.

*Hematoma* of the scrotum (Fig. 37) is an effusion of blood into the tissues of the scrotum or testicle. A *hematocele* is a hemorrhage into an already existing cavity, such as the tunica vaginalis. Hematoma rarely requires operation unless extensive, hematocele often does. It is therefore important to distinguish between them.

*Etiology* Scrotal hematoma, without rupture of the skin, is a not uncommon occurrence, especially in boys and athletes. It is usually the result of direct violence, such as a blow upon the scrotum or a severe crushing injury. Hematoma may also occur as a sequela of operation upon the scrotum or testicle.

Vaginal hematocele may be spontaneous, but that occurring in the scrotum is always of traumatic origin. It is possible to have both

hematoma and hematocele, as hemorrhage into the sac of a hydrocele will frequently be attended by infiltration of the scrotum or testicle with blood

The extreme vascularity of the scrotum makes hemorrhage, with the formation of hematoma or hematocele, the chief postoperative difficulty of surgical intervention in this region. Postoperative scrotal hemorrhage is due to improper attention to hemostasis in the course of intervention. The case with which a hematoma may form is readily understood when one considers the anatomical structure and blood supply of the scrotum. Not only are there abundant veins and arteries in the superficial cellular layer, between the skin and the fibrous tunic, but there are also innumerable venules and arterioles in the external layers of this same fibrous tunic. Here, too, are situated the vessels of the cord, tunica vaginalis, testicle, and epididymis. If even the smallest of these be severed, it can become the point of departure for a smart hemorrhage or an extravasation of blood into the interior of the scrotum, which may eventuate in the formation of a hematocele.

Perfect hemostasis in this region is difficult to obtain. The various scrotal layers are composed of very loose tissue, and the interposed cellular structure is of extreme fineness. These structural peculiarities favor extravasation of blood which infiltrates all the layers, working its way through adjacent tissues or collecting in some location where it will not aid in arresting the hemorrhage by clotting.

**Pathology.** Such an effusion of blood may occupy one of four locations. (1) Usually the blood inundates the scrotal space—that is, the cellular tract beneath the dartos, which separates it from the fibrous coat and the cremaster. (2) Very rarely a hematoma may occupy the scrotal septum, in which case diagnosis is difficult. Because of its median location it may be mistaken for a dermoid cyst. (3) In the third form—paravaginal hematoma—the blood collects between the tunica vaginalis and the fibrous coat. If there is a break in the fibrous coat, the blood will infiltrate the scrotal space. The existence of such a paravaginal space has been demonstrated by Kocher and Lemichez, who made injections which permitted them to study the arrangements of the tissues and to ascertain that a hematoma may form at three different points: in front of the testicle, under the testicle, and in front of the cord. (4) In the fourth type the hemorrhage is intravaginal (hematocele). A vaginal hematocele may leak through the incision made in tapping a hydrocele and thus reach the subcutaneous tissues of the scrotum, but

usually the effused blood lies between the dartos and the tunica vaginalis, under the testicle, in such a way as to raise the gland perceptibly

Blood thus extravasated into the scrotal tissues becomes thick and syrupy and finally coagulates into black clots about which the cellular tissue reacts until the clots are enveloped in fibrous tissue coverings of extreme hardness

A recent hematocele contains fresh red blood, but later the blood degenerates and takes on a brownish color. When the effusion of blood into the vaginal sac is a slow process, the blood coagulates and the walls of the tunica vaginalis are gradually overlaid with fibrin which adheres to the surrounding connective tissue, while the wall gradually thickens and becomes rough and uneven. As the clot is absorbed and organized into connective tissue, the walls become still thicker. When a hematocele has been long in existence, the surrounding sac wall will be found to be calcareous or even cartilaginous. Sometimes the entire cavity is obliterated leaving a mass which by pressure, may cause atrophy of the testis

Julian Taylor has reported a case of hematocele removed from the epididymis of a man aged 28 years following an accident 14 years earlier. He was unable to find any other example of hematocele enduring for so long a time without producing unbearable manifestations

**Symptoms** There is a wide difference in the rapidity with which a hematoma or hematocele may form. When there has been violent trauma, its formation is extremely rapid and attended by pain, but a *spontaneous hematocele may develop slowly and insidiously, thus resembling a hydrocele*. In the latter event, there is practically no pain and the swelling increases very gradually. If there is coincident hydrocele, the swelling decreases in translucency as the hemorrhage continues. The process of coagulation and organization is slow, and it is usually possible to observe upon the scrotal skin an increased warmth and irregularity of surface due to the presence of underlying clots. When these clots remain after the plasma is absorbed, they can be palpated as masses in the scrotum, and the dark coloration of the effused blood is visible through the skin

**Diagnosis** Diagnosis is not difficult if there is a history of recent trauma followed by rapid increase in the size of the scrotum. Hematocele may, however, exist without such a history. The differentiation from hydrocele is usually simple, hematoceles being heavier than hydroceles and not translucent. The Wassermann test will serve to rule out

*syphilis* Malignant tumors of the testicle, however, present points of resemblance that may introduce an element of confusion (Tumors of the Testicle, *Differential Diagnosis* p 458) Exploratory puncture, a dangerous procedure should the tumor prove to be malignant, is to be avoided if possible Should such puncture be necessary, the strictest surgical asepsis must be observed and where there is a suspicion of malignancy, preparation for immediate subsequent operation should be made in advance

**Treatment.** Treatment of an ordinary traumatic hematoma or hematocele is palliative unless hemorrhage is severe or suppuration occurs, when operative interference becomes necessary Extensive hemorrhage, with great distention requires incision of the sac, evacuation of the contents, and control of the hemorrhage If suppuration occurs, incision and drainage become imperative

In extravaginal hemorrhagic effusions in particular, surgical interference is rarely necessary, and the only treatment usually required is rest and elevation of the scrotum with the application of ice packs until bleeding has ceased, followed by hot applications to promote absorption

In the vaginal cavity, the final outcome depends upon whether or not the clot becomes infected If it does not, resorption usually takes place quite promptly, but when infection supervenes, resorption is delayed or, it may be temporarily inhibited entirely Sometimes suppuration takes place, resulting in true abscess-formation in the vaginal tunic The clot becomes purulent and is evacuated through the external integument In rare cases extensive gangrene may follow the evacuation of such an abscess but, as a rule, the regenerative properties of the scrotal tissue eventually result in perfect healing even in severe cases

In chronic cases, excision of the sac may be necessary

### *Traumatic Rupture of the Tunica Vaginalis in Hydrocele*

Considering the prevalence of hydrocele, traumatic rupture of the tunica vaginalis is not a common accident

**Etiology** Direct trauma, such as a blow or falling astride a hard object, is the usual cause

**Symptoms and Diagnosis** Rupture of the tunica vaginalis is immediately manifested by acute symptoms such as a tearing sensation and severe pain, with, sometimes, evidences of profound shock, even to complete loss of consciousness The scrotum quickly becomes edematous At first the edema affects only the injured side, but soon the

opposite side as well as the entire penis, becomes edematous. There will be more or less discoloration, depending on the extent of trauma to the blood vessels. The discoloration may be merely a slight 'black and blue spot' or a large hematoma may be present. A sharply limited swelling usually indicates that only the tunica vaginalis itself has been injured, but if the edema and discoloration extend to the abdominal wall, the chances are that the fibrous tissues are also involved in the rupture.

The diagnosis is usually not difficult to make.

**Treatment.** Surgery is the only adequate treatment. Spontaneous absorption may occur, but, on the other hand, gangrene with fatal sepsis, has been recorded.

## *2 Injuries of the Scrotal Contents*

Although the testicles appear to be in a highly exposed position, actually both these glands and the spermatic cords are so well protected by the enveloping scrotum, and so freely movable in their suspended position that injuries to them are comparatively unusual.

When trauma affects the testicle or epididymis, the pain is usually excruciating and the shock out of all proportion to the apparent gravity of the injury. Injuries of the scrotum alone produce less severe reaction and can by this means, readily be differentiated.

Lesions of the scrotal contents may be classified as *open* or *closed*. Open lesions include puncture, stab, and gunshot wounds. Closed lesions are principally contusions and dislocations. There may be direct trauma to the testicle and epididymis, or the injury may be indirect, resulting in lesion of the spermatic cord, with damage or destruction of the blood vessels and laceration of the vas deferens. Torsion of the cord frequently takes place usually with the sequela of gangrene or atrophy.

### *Wounds and Contusions of the Testicle and Epididymis*

**Gunshot Wounds of the Testicle.** Such wounds are quite frequently reported and are naturally more numerous in war literature. Frischer recounts a case wherein the bullet traversed the left scrotal sac, cutting off the globus major and the upper part of the testicle, lacerating the left cord and severing the vas deferens. It then passed through the right scrotal sac, completely dislodging the testicle, the right cord being retracted into the inguinal canal. The lacerated left epididymis was removed and the other structures repaired, the patient eventually mak-

ing a good recovery from his wounds and regaining potency. Three months later, however, no spermatozoa could be demonstrated in the semen.

In an injury reported by Thevenard a bullet entered the external surface of the left thigh and passed out through the inguino crural fold into the scrotum, tearing it to pieces, lacerating the urethra, and practically destroying both testicles. When seen, 7 days after being wounded in battle, the scrotum was hanging in ribbons and the debris of the testicles rapidly becoming gangrenous. At each micturition the urine flowed over the wounded area. Apparently no attempt was made to repair the damage to the testicles, for the author merely mentions that the scrotal wound "cleansed itself" while the testicular debris sloughed off, and that operation for the repair of the urethra was delayed because the patient contracted scarlet fever. Despite all this, however, healing took place, and when repair of the urethra was later undertaken a fragment of the right testicle, about the size of a hazelnut, was found adherent to the urethral canal. Subsequent examination showed that this testicular graft had apparently increased in size despite this; however, the patient had taken on something of a feminine type. This case illustrates the remarkable regenerative powers of scrotal and testicular tissue following traumatic injury.

**Contusions of the Testicle and Epididymis** Most contusions of the testicle and epididymis are sustained by horsemen, either from kicks or from violent contacts of various kinds while astride the animal's back.

The immediate effect is intense swelling and edema of the scrotum, often with ecchymosis and severe, nauseating pain, which radiates from the testicle to the thigh and the abdominal region. If palpation can be endured, the testicle will usually be found more or less enlarged. The swelling and congestion usually increase for several hours, then gradually subside, being limited to a certain extent by the inelasticity of the tunica albuginea. The firmness of this unyielding tegument tends to intensify the pain, and its compression increases the damage already sustained by the testicle. Some surgeons even recommend incision of the tunica albuginea for the relief of pain and to lessen the likelihood of atrophy from pressure. Subsidence of the initial nauseating pain is followed by a severe, constant ache which is aggravated by standing or walking.

The diagnosis is usually readily made on the history and symptoms, but the possibility of torsion, infection, strangulated hernia, and neoplasm must be kept in mind.



**Explosive Rupture of the Testicle** Explosive rupture of the testicle from trauma has been reported. In Cotton's case the patient was struck in the scrotum by a ball while witnessing a baseball game. The swelling and discoloration were considerable, and as he had previously suffered from a varicocele a diagnosis of rupture of the varicocele was made. Operation disclosed a mass of blood clots, and when these were evacuated it was found that nothing remained of the testis but shreds adherent to the tunica albuginea. It had evidently exploded under the impact as a full bladder bursts under a blow. The epididymis and cord showed little damage.

**Prognosis** The prognosis in testicular injuries should be guarded, for atrophy of the testicle may follow even a slight injury, being dependent, apparently, upon the formation of scar tissue or infarction.

**Treatment of Wounds and Contusions** Treatment of wounds and contusions of the scrotal contents is directed toward the immediate reduction of the acute symptoms along the lines laid down for the treatment of scrotal wounds (p 400). Every effort should be made to avoid infection and to preserve as much of the testicle as possible. Hemorrhage must, of course, be controlled at once, and shock, which is usually severe, combated by the routine supportive measures, all attempts at examination being deferred until the patient rallies.

In general, a patient with an injured testicle should be put to bed immediately, given proper purgation, and placed on a bland diet. Sedatives are given for the relief of pain if the injury is of recent origin. Codeine, 0.06 Gm (1 grain), by hypodermic injection, or one of the barbituric acid group of drugs, is usually satisfactory. In every case of injury to the intrascrotal organs, the scrotum should be put at rest (when it is not actually being treated locally) by a properly applied suspensory (p 519). If allowed to hang down, it becomes congested and may even be squeezed.

**Wounds** Slight incised wounds of the testicle and epididymis frequently heal promptly without operative intervention if they are kept clean and the measures outlined above are followed. The wound should be carefully cleansed with soap and water, followed by an antiseptic solution such as *rivanol* dextrose, 2 per cent, alcohol, 30 per cent, tincture of merthiolate, 10 per cent, or potassium permanganate, 1:8,000 if the wound is very foul. As healing progresses, iodine solution, balsam of Peru, or Durante's solution may be used to stimulate the tissues. Dakin's solution has a definite place in the care of such wounds.

The sulfonamides are very efficient in preventing and combating in-

fection in wounds of the scrotal contents. In gunshot, shrapnel, puncture, and other wounds where infection is likely to set in, the systemic as well as the local use of sulfonamide therapy is advisable.

In such wounds it is also wise to administer a prophylactic dose of anti-tetanus serum.

In the later stages of healing, the use of ultra violet ray therapy may speed the repair of a sluggish wound.

More severe wounds of the scrotal contents require immediate operation with repair of the damaged parts and drainage of the scrotum after proper antiseptic applications have been made. Removal of the testicle may be necessary. Surgical drainage is usually advisable in all wounds of the scrotum and its contents, except slight incised wounds, because the areolar tissue with which the scrotum is lined soaks up the blood rapidly, forming a large, hard mass which may not subside for weeks.

If the tunica albuginea has been opened to any extent, careful and immediate surgical repair is essential to prevent hernia of the testicle. If hernia occurs, it should be reduced if possible, without loss of substance and the torn envelopes carefully sutured.

*Contusions* Slight and moderate contusions of the testicle or epididymis do not usually require operative intervention, but are satisfactorily treated by rest in bed, elevation and support of the scrotum, and the application of cold or hot compresses. Cold applications are preferable if bleeding is present, but when hemorrhage has ceased, hot applications are substituted to promote absorption. Surgical drainage becomes necessary when hemorrhage is excessive (as it often is when the tunica is ruptured), or when the presence of fluctuation indicates that infection has occurred. Severe contusions are likely to result in atrophy of the testicle regardless of treatment, and even mild contusions may produce a typical orchitis or epididymitis, which disappears in time under appropriate treatment. During convalescence the patient should wear a scrotal suspensory.

### *Surgical Injuries*

Occasionally, the tunica albuginea of the testicle is torn during removal of a diseased epididymis. In such cases the stringy testicular substance is replaced and retained by a mattress suture of plain catgut.

In operations for the radical cure of inguinal hernia the vas deferens is sometimes divided during dissection of the sac. This is particularly likely to happen in little boys, in whom the vas is very slender. In the

infant, the vas is a thin white cord which easily may be mistaken for the margin of the hernial sac. Separation of the spermatic vessels and cord from the hernial sac should be accomplished by traction upon the fascia on either side, thus avoiding injury to the structures themselves, which may happen if they are seized with forceps. In young children the vessels are very small and easily traumatized, and if bleeding sets in it is difficult to apply hemostats to such tiny structures.

Atrophy of the testicle not infrequently follows operations for hernia, cryptorchidism, hydrocele, and varicocele, due, probably, to interference with the blood supply of the testicle.

### *Luxation (Dislocation) of the Testicle*

Luxation, or acquired malposition, of the testicle is rare, and appears to be always dependent upon trauma. Alvea, reviewing the literature in 1929, found only 23 cases reported in the 130 years between 1800 and 1929, all of which followed trauma. Nine resulted from the genitals being run over by a wagon wheel and 14 from blows and automobile and train injuries.

The luxation may take various forms, depending upon the direction of the blow and certain anatomical peculiarities. Internal (deep) luxation results in displacement to the inguinal canal, the abdomen, or the femoral canal. External (superficial) luxation, by far the more common, results in subcutaneous inguinal, penile, pubic, perineal, or crural ectopy. In compound luxation, the testis is dislocated through the ruptured scrotal wall.

**Treatment** Treatment is replacement of the testicle at the earliest moment. This may occasionally be possible without operation, but usually surgical intervention is necessary.

### *Relighting of Old Inflammatory Lesions*

Occasionally, injury to a testicle is followed by an inflammatory condition out of all proportion to the severity of the preceding trauma. A carefully elicited history in such cases not infrequently reveals a previous gonorrheal epididymitis which the testicular trauma has served to relight. This possibility is of especial importance in industrial medicine and to insurance companies.

The prevalence of chronic gonorrhea, and the frequency of acute exacerbations of the epididymo-orchitis from injury or strain, have developed a tendency on the part of commissions of industrial medicine,

insurance companies and even physicians to regard as primarily venereal the majority of acute infections arising from industrial injury or strain. This is often unfair to the worker. Non gonorrheal infections are also prevalent and trauma or strain may be the exciting cause of an acute epididymo-orchitis. Differentiation of venereal exacerbations for which workmen are not entitled to compensation from primary traumatic lesions of a purely industrial nature for which they are is sometimes very difficult but in fairness to both sides the physician must make every effort to distinguish between them. Such differentiation necessitates a carefully elicited history and a most complete examination. The untruthful patient is hard to detect. Several weeks may be required for observing and studying the case before a definite diagnosis can be made since the acute condition must often be treated before the examination can be completed.

### *Autolysis of the Testicle*

Autolysis or complete spontaneous disappearance of the testicle is exceedingly rare. In Andrews and Oslund's case the patient was 21 years old but appeared younger, had never shaved and had no desire for women. The distribution of hair was of the feminine type but the genitalia were of normal appearance although undersized. The scrotum was normal but empty of testicles. Careful examination of the inguinal region on each side failed to reveal the presence of any testicles in the canals or sign of herniation. Believing the case to be one of cryptorchidism with the testicles probably retained in a high position operation was undertaken. On opening the right inguinal canal it was found to be most surprisingly empty. The only cord element present was a normal appearing vas which stretched the entire length of the canal and disappeared into the scrotum. Traction upon the vas withdrew from the scrotum the remains of the testicle. This consisted of a very small epididymus and a fully developed tunica albuginea which was however completely empty. There was no tunica vaginalis.

Because the vas was well developed and the tunica albuginea of normal thickness the authors were inclined to believe the condition to be acquired probably about the fifth year judging by the size of the tunica albuginea.

There was no history of trauma in this case. Oslund's experimental work on the testes of young rats and guinea pigs has however demonstrated the frequency of complete autolysis of the testicle following

trauma When a wedge shaped piece was cut out of the gland and the edges of the tunica vaginalis sutured together over the wound, complete loss of glandular tissue followed in a few months He also describes an ancient method of producing eunuchs by squeezing the testicles of young boys between the fingers while they are immersed in hot water These observations emphasize the dangers of traumatic injury to the testicles of young boys, and likewise offer an explanation of certain cases of male sterility for which no adequate cause has heretofore been found It is not unlikely that autolysis of the testicle in the human occurs with greater frequency than is at present recognized

### *Torsion of the Testicle*

Torsion of the testicle is caused by sudden twisting of the spermatic cord, resulting in an acute strangulation of the blood vessels supplying the testicle and epididymis It is dependent upon anomaly in the position of the elements of the spermatic cord, testicle, or epididymis Though torsion may occur with fully descended testicles, it is much more frequent in those in whom the testicles have failed to descend About 250 cases of torsion had been reported in the literature up to 1935 (Kinney)

**Etiology** The primary etiological factor in torsion of the testicle is a high investment of the gland and its adnexa (Muschat) The testicle cannot become twisted unless it is freely movable It must be unattached at either side and suspended in the vaginal sac by a long spermatic cord As this is an abnormal situation, it is evident that torsion depends upon some congenital anomaly

During fetal development the gubernaculum, by gradual shortening, exerts traction upon the testicle When the gland has reached the scrotum, it is held firmly in place by the remnant of the gubernaculum (scrotal ligament), which forms a dense fibrous attachment between the most dependent part of the scrotum and the tunica vaginalis The testicle is eventually surrounded by the tunica vaginalis, but the epididymis is never completely invested, its posterior portion remaining outside the vaginal sac and adherent to the inner scrotal wall Therefore, when development has proceeded along normal lines, torsion is impossible

Muschat's investigations showed that in torsion cases the tunica vaginalis completely invests not only the testicle but the epididymis and the cord above the testicle's attachment, thus making the testicle, epididymis, and distal spermatic cord, wrapped in their vaginal tunic,

an "extravaginal body" hanging free in the vaginal sac, with no lateral attachment to the scrotal wall. When in the course of development the vaginal process on the upper portion of the cord disappears, the sac of the testicle becomes entirely independent. Cross sections of the scrotum show that instead of a partial investment, as is normal, the testicle and epididymis subject to torsion are completely included within the vaginal process.

Abnormal conditions anatomically favoring torsion are (1) an unusually capacious tunica vaginalis, (2) failure of the tunica vaginalis to close completely, (3) absence of the gubernaculum testis and posterior mesorchium, (4) absence of the scrotal ligament, (5) abnormal attachment of the common mesentery and vessels to the lower pole of the testis and to the globus minor, so that the testis instead of being attached by a broad band is connected merely by a narrow stalk, (6) elongation of the globus minor, (7) abnormal length and loose attachment of the intra vaginal portion of the cord, (8) looseness and flabbiness of the tissues connecting the testicle and epididymis, (9) abnormality of the epididymal attachment to the scrotum, (10) combinations of these anomalies with imperfect descent.

The immediate cause of torsion of the testicle appears to be spastic contraction of the cremasteric muscle. A rational explanation is that torsion is brought about by contraction of the anomalous cremasteric fibers in conjunction with abnormal attachment of the testicle, deficiency in the gubernaculum, and an unusually large vaginal sac (Uffredussi, Muschat). Commonly the patient gives a history of lifting, straining, jumping, or other muscular exertion, but in many of the reported cases the condition came on during sleep or followed the injudicious application of a truss.

**Pathology** The first effects of torsion are hemorrhage and congestion, all the structures below the twist showing hemorrhagic infarction. In proportion to the extent to which they have been occluded by the torsion of the cord, the spermatic veins above the twist will be distended, flattened, or partially obliterated. The spermatic artery, however, though always much distended, will usually be found pervious. The twist is invariably located in the free portion of the cord within the vaginal sac, just above the testicle, and may vary in extent from a half turn to two full turns. It may be in either direction, although from within outward and forward is more common. Fluid is regularly present within the sac—serous in early cases but bloody in the later stages. If the twisting is slight, the circulation may be but little interfered with, and swelling

and pain transitory and not marked. Even slight torsion, however, is usually productive of atrophy, and many cases of "spontaneous" atrophy of the testicle are probably due to an antecedent torsion that caused but little discomfort. Usually, however, the torsion is severe, and if not promptly untwisted, gangrene of the testicle may result, and atrophy almost invariably.

Section of the affected parts shows intense engorgement, with complete atrophy of the testicle in cases of longer standing. Hydrocele is a common accompaniment of torsion and gives rise to adhesions which anchor the testicle in its twisted position.

Torsion of the testicle can occur at any age even in infancy but it is seen most often in adolescence. The right spermatic cord and testicle are involved in the ratio of about 3 to 2.

**Symptoms and Diagnosis.** Acute torsion of the cord closely resembles and is often mistaken for acute epididymitis, orchitis, strangulated inguinal hernia, or incarcerated omental hernia. The twist shortens the cord so as to give the scrotal contents the appearance of having been pulled up into the groin. Edema sets in rapidly. Nausea and vomiting and even chills and fever may occur. Tenderness on palpation is usually less marked than in an acute infection. Diagnosis is based chiefly on a sudden onset, with severe pain, elevation of the testicle, and the fact that the swelling is confined to the lower part of the inguinal canal—the last two being the only really pathognomonic signs. Early diagnosis is imperative. Mild cases are sometimes undiagnosed until they have led to atrophy of the testicle.

**Treatment.** Torsion of the testicle is a very serious occurrence and in most instances leads to sterility of the affected side. It is distinctly an emergency condition and treatment must be prompt. Even if the cord can be untwisted, the chances are that atrophy will occur. Gangrene and even atrophy can occasionally be prevented in acute cases if operative measures are undertaken within a few hours. If, after the cord has been untwisted, the testicle quickly regains its normal color, it should be anchored to the bottom of the scrotum to prevent recurrence of the torsion. Surgery is usually the only recourse in torsion—sometimes orchidopexy but more often orchidectomy (p. 495).

The opposite side should be inspected in all cases of torsion and if the testicle shows undue mobility, it, too, should be anchored.

In an interesting case of Lowsley's the patient had torsion of the testicle, with all the usual severe symptoms. While coming to the office in a cab, the cord untwisted itself, and the symptoms promptly subsided.

### *Torsion of Hydatid of Morgagni*

Torsion of the hydatid of Morgagni is apparently a very rare condition. Such a case was recently seen by us at the Brady Foundation.

The patient, an 8 year-old boy, had severe pain and swelling of the right scrotum of 2 days duration, without fever, nausea, or other systemic manifestations. There was no history of direct trauma, although he had been playing and sliding down banisters. The skin of the right scrotum was edematous and red and the globus major of the right epididymis was extremely tender to palpation. The tunica vaginalis was somewhat distended with fluid. Operation revealed a twisted purple mass at the site of the hydatid of Morgagni. The hydatid was removed and the patient made an uneventful recovery, the symptoms subsiding with the removal of the twisted hydatid.

## B DISEASES OF THE SCROTUM AND SCROTAL CONTENTS

### *1 Diseases of the Scrotum*

#### *Cutaneous Affections*

The scrotum, in common with other areas of cutaneous tissue, is subject to a variety of skin affections, such as scabies, pediculosis, prurigo lupus, eczema, and so on. These are treated in the same way as when they occur elsewhere on the body, except that the unusual delicacy and sensitivity of the scrotal skin contraindicate the use of certain local applications which are serviceable elsewhere.

**Scabies.** The itch mite, though evidencing a predilection for the hand and arm, frequently invades the scrotum and penis and under crowded and unsanitary conditions, such as those surrounding troops in war time, may become remarkably prevalent in these locations. The disease is contagious and generally is acquired by sleeping with an infected person. It is due to the *Acarus scabiei*, which bores its way into the skin, forming little burrows in the epidermis. Itching is intense and is worse at night. In any itching dermatitis of the scrotal region, a search should be instituted for the characteristic burrow and an attempt made to demonstrate the presence of the acarus or her ova. The actual presence of the acarus produces no inflammatory reaction, but skin lesions due to scratching frequently change and confuse the clinical picture.

**Treatment.** Treatment does not differ in any way from the mode of handling this parasitic invasion on other cutaneous areas except that the extreme sensitivity of the scrotal skin must always be considered.

**Pediculosis Pubis.** The invasion of pediculi pubis may cover the genital region with "crabs" and their ova. The parasite is generally not seen by the patient because of its position at the base of the hair shaft.



The ova appear as small shiny spots and bluish maculae distributed over the base of the thigh and adjacent parts. To those familiar with its appearance it is ordinarily easy to detect the parasite, which is attached to the pubic hair by four claws, lying flat upon the skin and adherent to it.

**Treatment** If only a few parasites and ova are present, they are most readily eradicated by pulling out the affected hairs. When very numerous, this will, of course, be too slow and painful. The application of purified xylol has been recommended. This benzine causes smarting of the skin, and the application should not last more than 2 or 3 minutes. Though all the parasites and eggs are instantly destroyed, there is risk of slight chemical dermatitis, but this may be prevented by the immediate application of zinc oxide ointment. The application of equal parts of petroleum and balsam of Peru at night, followed by a thorough bath in the morning, quickly destroys the parasites. Another method of cure is to shave all the hair and burn it, then apply to the skin a 10 per cent calomel, sulphur, or zinc ointment containing 10 grains of beta naphthol to the ounce.

**Prurigo** Prurigo is a cutaneous disease characterized by a persistent eruption of pale inflammatory papules, which itch intensely and result in excoriation and secondary infection. While quite common in Central Europe, the disease is infrequently encountered in American clinics. It is most common in the very poor and undernourished. The papules regularly appear on the buttocks and thighs and may occasionally spread to the scrotum, when they are most likely to be found on the perineal surface, upon and around the raphe.

The etiology is obscure. The disease ordinarily begins in infancy or early childhood with urticarial lesions and often persists for years or a whole lifetime, treatments having little effect. The papules are pale in color and about the size of a millet seed. They itch intensely, so that scratching soon leads to excoriation with crust formation and secondary infection. If secondary infection is deep enough to invade the lymph channels enlargement of the inguinal nodes will occur. In an adult, the combination of genital lesions and inguinal adenopathy may suggest malignancy or syphilis, but a careful history and microscopic examination of the skin lesions should serve to differentiate the condition.

**Treatment** Prurigo is a serious, persistent, and often crippling or even fatal, disease, and was long regarded as incurable. Lately, however, relief has been afforded in some cases by treatment with ultra-violet light, high frequency exposures, or roentgen ray. Local anti-

pruritics, with tonics and general hygienic treatment, also have been found beneficial. Wilkinsen's salve, a combination of tar, sulphur, and green soap, is recommended by several leading dermatologists.

**Pruritus Scroti** Pruritus is not a disease, but a condition characterized by itching, burning, or smarting sensations. The use of the term "pruritus" is limited by present day dermatologists to the essential incidence of itching without any apparent primary dermatitis.

Pruritus scroti may be of nervous origin or associated with systemic disease, such as diabetes, syphilis and tuberculosis, or due to a protein sensitization or to a local lesion, such as hemorrhoids and fissures. It is sometimes due to a high icterus index. The pruritus may be confined to the scrotum, or may extend all over the genital region and be so severe as to affect the health of the patient. Excoriation of the skin by scratching is likely to lead to secondary infection.

Cutaneous affections, such as scabies, pediculosis pubis and prurigo, must be excluded.

**Treatment** If a thorough physical examination including a proctoscopic inspection shows no constitutional condition, anal lesion, or other cause for the itching, purely local treatment must be relied on. The chief aim should be to prevent scratching which occurs most often at night, when the itching is usually most intense. Skin sedatives and antipruritics such as lead and-opium wash and recommended salves and dusting powders are frequently beneficial. Some form of phenol introduced in salve, powder or lotion is usually most effective, although some patients react unfavorably to phenol in any form. As a last resort, undercutting of the nerve-endings has been recommended.

If a systemic or anal cause for the pruritus can be demonstrated this must, of course, receive treatment.

**Other Cutaneous Affections** *Eczema* in its various manifestations may affect the skin of the external genitalia, and is generally the result of some obscure metabolic disturbance. *Erysipelas* of the scrotum is usually an extension from broken down inguinal lymph nodes resulting from chancroidal infection or malignancy. It is characterized by vivid redness and edema of the skin, associated with fever, and is due to a specific streptococcus. *Psoriasis* may occur on the genitals and in the groins. It is characterized by the occurrence of sharply circumscribed roundish, silvery patches with infiltrated bases. *Lupus* and *lichen* may also be found upon the scrotum.

**Treatment** In all of these treatment is the same as for the particular

lesion elsewhere on the body In many skin affections of the scrotum roentgenotherapy has proved very effective as has also heliotherapy

### *Chancroid*

Chancroid upon the scrotum does not differ in its manifestations from that upon the penis (p 261) Here as there it is a specific local contagious auto infectious venereal ulcer which flourishes where soap and water are not esteemed Although beginning as a single ulcer auto inoculation is so constant that by the time the lesion comes under observation several ulcers will commonly be found in close relation These if untreated may spread to any part of the external genitalia The follicular form of chancroid commencing in a sebaceous cyst may be mistaken for an acne pustule or an insignificant boil

### *Syphilis of the Scrotum*

The literature is surprisingly silent concerning syphilis of the scrotum One may search the files of journals devoted both to urology and venereal diseases scan the indices of text books on syphilis or consult the files of hospitals and clinics without finding more than the barest mention of syphilitic infection of the scrotum Yet Harrison one of the few text book authors to give the subject adequate attention—states that primary syphilitic sores are found fairly often on the scrotum and that secondary lesions are common Stokes also remarks the frequency of annular recurrences in this region Jeanselme and Lefevre in their contribution to the elaborate *Traite de la Syphilis* likewise make brief mention of the prevalence of scrotal manifestation of the disease but aside from these representative authors in three countries the literature is almost silent Syphilitic elephantiasis should be excepted from the foregoing statements There is a considerable literature regarding this Late elephantiac manifestations in the scrotum Stokes believes are rare and more often observed in the Negro than in the white race

**Primary Chancre of the Scrotum** Routine physical examination in urology should always include a careful inspection of the scrotum for dermatological lesions This organ is a very common site for such secondary lesions as condylomata soft papules and recurrent syphilides The abundant papular eruption often suffered by the scrotum may be so irritated by contact with urine or the friction of clothing as to become ulcerative or it may resemble a pruriginous affection If there has been a primary chancre on the scrotum such secondary lesions may com

pletely obscure the evidence To look for the scar of a healed chancre, the loose scrotal skin should be lightly stretched and the surface examined in a good light Annular recurrences are most often found upon the posterior surface

Chancre occurs quite frequently at the penoscrotal junction, and because of the constant mobility of these parts is likely to be painful, a fact which often causes confusion to those who seek only a "painless" ulcer Otherwise, primary chancre does not differ from the typical penile lesion (p 262) It is ulcerated or eroded in the center, with a surrounding grayish white zone, and an outer, more diffused area of typical inflammatory red It is often covered by a necrotic membrane Palpation will reveal the surrounding tissue to be infiltrated for a considerable distance The degree of induration of the ulcer base varies in different subjects, but, as a rule, a scrotal chancre remains much softer than a similar lesion upon the penile shaft The diagnosis should always be made by dark field examination and suitable blood tests, and every ulcerated lesion upon the scrotal skin should be looked upon with suspicion until it has been proven non syphilitic

**Secondary Lesions of Syphilis upon the Scrotum** Secondary syphilitic lesions may occur on the scrotum as moist papules or as broad condylomata, the latter being found most often at the points of union with adjacent structures—the penis or the thigh

The moist papule is observable as a raised pinkish plaque, often surrounded by a ridge of darker red If the scrotal skin is stretched during the examination (as it should be), this area will sometimes exude a thin serum and will show as a glistening white ridge—an appearance peculiar to a syphilitic lesion and almost sufficient in itself to establish the diagnosis, if noted by an experienced eye

Condylomata upon the scrotum, as elsewhere in the genital region, are warty growths flourishing in those spots where heat and moisture favor their growth In general, they are like similar growths upon the penis (p 297) and their treatment is the same The diagnosis should be positively established by laboratory examination, and the patients instructed in personal hygiene, the lack of which is practically always the main reason for their occurrence

Still another form of syphilitic infection which is occasionally manifested in this region is gumma, although in the majority of instances it is not primary but an extension of a process having its origin in the testicle

*Granuloma Inguinale*

Granuloma inguinale, which is discussed at length under Diseases of the Penis (p 278), may affect the scrotum also. The lesion begins as a relatively insensitive papule, which later breaks down, and, resisting all attempts at healing spreads rapidly over the surrounding tissues. Its course in the scrotal region is similar to that in penile involvement. The diagnosis is readily made by the characteristic appearance of the lesion and the detection of the Donovan organism. Treatment by intra venous injection of tartar emetic has proved effectual.

*Gangrene of the Scrotum and Penis*

Gangrene of the scrotum and penis is not uncommon. It is of two types: (1) *secondary gangrene*, which may follow trauma, may be secondary to some systemic disease such as diabetes and the infectious diseases, or may be the terminal stage of a local pathological process such as periurethritis, phimosis, chancroid, or erosive and gangrenous balanitis, (2) the so called "idiopathic" or *spontaneous fulminating gangrene*, which is characterized by a sudden and apparently spontaneous onset and a fulminating course. It is with the latter type that we are here chiefly concerned.

**Historical.** Among the earlier writers on scrotal gangrene the studies of Whiting (1905), Randall (1920), and Campbell (1922) are the best. In 1930, Thomas E. Gibson published an excellent discussion of idiopathic gangrene of the scrotum and tabulated 206 cases collected from the literature. Considerable attention has since been given the subject by writers in Germany and Italy.

**Etiology of Spontaneous Fulminating Gangrene of the External Genitalia.** The term *spontaneous fulminating gangrene* is used to designate a gangrenous condition of the scrotum or penis arising without known antecedent trauma or disease. The condition is known by a variety of names: acute essential gangrene of the scrotum (Gorowitz), idiopathic scrotal gangrene, gangrenous erysipelas of the scrotum, streptococcus scrotal gangrene (Campbell), and spontaneous fulminating gangrene—the name given it by Fournier who was the first to publish a complete description of the disease (1883).

The most probable predisposing factors of scrotal gangrene are (1) the laxity of the cellular tissue, permitting marked infiltration, and (2) the looseness of the skin, which diminishes resistance to infection. Age apparently is not a factor, since cases have been recorded in patients

ranging from 2 to 71 years of age. Trauma does not appear to be of etiological importance, but it is possible that a concomitant lesion, such as urethritis, inguinal adenitis, or phimosis may afford a portal of entry

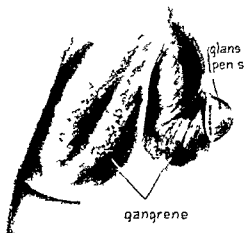
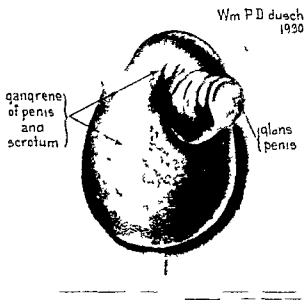


FIG 79 Gangrene of the scrotum and penis following periurethritis.

The disease is undoubtedly infectious though no invariable causal organism has as yet been detected. Many cases closely resemble the

gas gangrene of infected wounds, and the gas bacillus has been repeatedly found. Frequently, however, the *Bacillus aerogenes capsulatus* (Welch bacillus) cannot be demonstrated. The *Streptococcus hemolyticus* is held responsible by Campbell in the 6 cases reported by him, but he makes no mention of observing the characteristics of gas gangrene, such as formed one of the chief findings in the case which occasioned Gibson's paper and in some of those earlier reported by Randall. Randall recognizes two types (1) that caused by the gas bacillus, and (2) that caused by streptococci and unaccompanied by gas in the tissues. Many observers believe the condition to be intimately allied with erysipelas. The variety of opinions bears witness to the uncertainty of knowledge regarding the etiology, as well as to the general inclination to believe that it is due to specific infection.

**Symptoms and Diagnosis** The most striking characteristics of this infection, as Fournier originally pointed out, are (1) its sudden appearance in the midst of apparently perfect health, (2) its rapid progression to the gangrenous state, (3) the complete absence of any of the usual causes of a gangrenous process.

The onset is marked by sudden rise of temperature and great prostration. Chills, rapid pulse, pallor, even nausea, vomiting, and delirium accompany the swift development of the local condition in the scrotum. The affected parts soon assume enormous proportions, sometimes trebling in size within 24 to 36 hours. The tissues are hot and exquisitely painful, the skin tense, shining, and sensitive to the slightest pressure. Edema rapidly supervenes. There is pitting of the surface on pressure, the shining redness becomes dull, exudation commences, and the greenish hue of gangrene, together with its characteristic fetid odor, becomes perceptible. It is sometimes possible, by palpation of the edematous tissues, to elicit crepitation before the onset of the gangrene.

The gangrene spreads rapidly, sometimes from several foci of necrosis which seem to appear simultaneously in various parts of the genital region. Soon a line of demarcation is established and the gangrenous areas, if multiple, coalesce to form one gangrenous mass. Occasionally the gangrene spreads to the groins, pubes, and even to the umbilicus. Involvement of the penis does not extend beneath the shaft of the corpora cavernosa, and that of the cord and testicle is limited by the sheath and tunica vaginalis. Sloughing of the testicles does not occur and the skin of the thigh is singularly free from involvement.

Sloughing usually takes place 5 to 8 days after the onset of the acute symptoms. When the slough has separated completely and the danger

of acute hemorrhage been overcome, the patient has a good chance of survival. Death from profound toxemia may take place within 72 hours, however, and always the disease must be regarded as most serious in its nature.

The separation of the slough is a time of danger because of hemorrhage which is almost certain to be severe, and careful watching is essential. When this crisis has been successfully passed, recovery is almost assured. Healing by granulation begins at once and proceeds with surprising celerity, and complete regeneration of the scrotum about the denuded testicles usually occurs in from 8 to 12 weeks.

Spontaneous fulminating gangrene must be differentiated from other types of scrotal gangrene, particularly that following periurethritis with extravasation of urine.

**Treatment and Prognosis.** Treatment of gangrene of the scrotum and penis secondary to trauma or periurethritis with extravasation of urine, phimosis, or systemic disease is wide excision with multiple rubber tube drainage.

As most of the cases of fulminating gangrene of the external genitalia appear to be closely related to, if not identical with, gas bacillus infection, the methods advocated for the control of the latter would seem to be applicable here also. The usual method of treatment is by free incision and removal of the gangrenous tissue according to the *debridement* methods instituted in the treatment of war wounds, with irrigation by Dakin's solution or complete immersion of the parts by having the patient sit in a bath of warm potassium permanganate solution. Another method of treatment is free incision of the affected areas with the placing of multiple drainage tubes for continuous irrigation with peroxide and oxygen. The patient will usually be profoundly toxic, and suitable supportive measures (blood transfusions, infusions, caffeine, sulfonamide therapy, etc.) must be utilized to offset this.

Greater attention should be given to the study of anaerobic infections of the external genitalia and of the urogenital tract in general by those interested in the bacteriology of urological diseases. Since all gangrene is probably of an anaerobic nature, early treatment by anaerobic antitoxin and antigangrenous serum would seem highly logical and worthy of trial in the fulminating type at least. The whole subject is deserving of more study than it has received in the past.

The care of the convalescent patient is of great importance, and the rapidity with which recovery sets in, in those cases which weather the



crisis, must not lead to a too sanguine view of the outcome. In Gibson's table of 206 cases the mortality was 26.7 per cent, and the records of individual surgeons give even higher percentages in several instances.

### *Abscess of the Scrotum*

Abscess of the scrotum is usually due to infection with a pyogenic organism. The abscess may start in the skin, or it may originate from

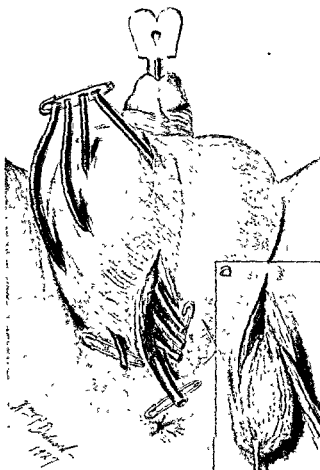


FIG. 80 Abscess of the scrotum. Incision and drainage with multiple rubber tubes.  
(a) A slough of the scrotum in the process of being removed.

the epididymis and extend throughout the scrotum and, if untreated, finally rupture.

**Treatment.** The treatment is wide incision and drainage with multiple rubber-tube drains (Fig. 80).

*Elephantiasis of the Scrotum*

Elephantiasis of the scrotum is a condition characterized by hypertrophy of the skin and subcutaneous tissue and marked scrotal enlargement produced by local disturbance of the circulation (Fig 43). There are two types: (1) elephantiasis arabum (filariasis) the true tropical form due to infection with *Filaria sanguinis hominis*; (2) elephantiasis due to lymphatic stasis from other causes and seen in temperate as well as tropical countries.

Elephantiasis arabum is only occasionally encountered in temperate climates, the few cases observed here being importations. It does occur however in our island possessions and is therefore of interest to naval surgeons and those whose professional activities take them into tropical regions.

**Etiology and Pathology.** The true tropical elephantiasis is due to blocking of the lymph channels of the scrotum's return circulation by parent female *Filariae sanguinis hominis* (*Filaria Bancrofti*). This organism belongs to the family of parasitic nematoid worms called the *Filaridae*. The adult filariae are found in the lymphatic glands of the pelvis and abdomen and in cystic dilatations of the subcutaneous tissues of other structures besides the scrotum. The infestation is communicated to man by means of various species of the *Culex* mosquito.

The larvae appear in the blood of the victim as transparent cylinders of about the size of red blood corpuscles. Blood specimens examined immediately after being obtained will show the larvae encased in sheaths and moving vigorously. The larvae usually absent themselves from the peripheral circulation during the day, and specimens drawn then will be repeatedly negative. The organisms apparently retire to the large arteries and linings of the blood vessels but at night they return to the peripheral circulation so that a specimen drawn about midnight will be literally teeming with them. A mosquito biting an infected person in this stage will take in the larvae which escape from their sheaths while in the insect's digestive canal acquire locomotive powers and eventually (in about 3 weeks) progress to its proboscis. The mosquito is now ready to infect any human being it may bite or it may deposit the larvae in water where they may or may not be drowned.

The larvae entering the human body rapidly gain the lymph channels and becoming sexually mature deposit larvae in their turn. Blockage of the lymphatic system of the scrotum the direct cause of elephantiasis is due to obstruction of the lumina by the adult worm which may serve

as the basis for a thrombus or result in so much inflammation as to cause the walls of the vessel to adhere to each other. Lymphatic stasis in the scrotum results. Inflammatory changes of the locally dilated lymphatics then occur, and imperfect absorption of the products of inflammation leads to progressive thickening and hypertrophy. The parasite cannot be communicated directly from one human being to another, the mosquito must always act as an intermediary.

Filarial infestation may produce lesions in the scrotum and elsewhere without clinical demonstration of the parasite being possible. Four such cases were reported several years ago (H. H. Young), all patients being citizens of Colombia, South America, temporarily resident in the United States. Filariasis being common in Colombia when these patients presented themselves with swellings in the testicular region the possibility of filarial infestation was immediately thought of. At no time while the patients were being observed, however, could the characteristic parasite be demonstrated in the blood.

The non filarial type of elephantiasis, although clinically resembling the tropical form, is etiologically unassociated with it. It is caused by stasis of the scrotal lymphatics due to chronic inflammation. Syphilitic hyperplasia, which is fairly common in American born Negroes, may produce a pseudoelephantiasis of the scrotum. Trauma, inguinal adenitis, or congestion resulting from a low grade bacterial infection of the lymphatics may form the basis of non filarial elephantiasis, or chronic lymph scrotum. As in the filarial form, the lymphatic stasis results in imperfect absorption of inflammatory products, stimulating hypertrophy of the skin and subcutaneous tissues. Recurrent attacks lead to progressive enlargement.

**Symptoms and Diagnosis.** The chief clinical manifestation of elephantiasis is a widely diffused enlargement of the scrotum, due to tremendous hyperplasia of both skin and subcutaneous tissue, together with an indurated edema. At the outset there is only trifling edematous enlargement. This gradually increases the increase in size being accompanied by rise of body temperature, malaise and, later, cellulitis and lymphangitis. Sometimes the symptoms all subside and the scrotal enlargement diminishes, but these remissions are brief and with each recurrence the size of the scrotum progressively increases.

The thickening and roughening of the skin is most noticeable upon the lower part of the scrotum, giving that structure a piriform shape, with the smaller end pointing backward toward the anal region. The penis

is not usually involved, but appears smaller and becomes retracted by the gradual extension of the surrounding scrotal tissues. It may almost entirely disappear in the edematous mass, nothing being visible but an opening through which a catheter can be passed only with the greatest difficulty. In enormously distended scrotums, there will sometimes be several small hydroceles. Secondary conditions such as ulceration, eczema, or other skin diseases, are frequently seen as the result of trauma and bacterial invasion of the damaged integument.

In filarial elephantiasis the scrotum often reaches enormous proportions. As a rule, the non-filarial types are milder. Patients usually suffer no discomfort except for the size of the parts involved. There is rarely pain save that which results from the effects of secondary infections. Although complete atrophy of the testicle is not uncommon, the patient is seldom aware of it. During exacerbations of lymphangitis there is usually local discomfort and fever.

The history is of importance. Because of the nocturnal habits of the filaria, its demonstration in the blood often consumes considerable time and patience. The blood samples should be drawn around midnight.

**Treatment.** Radical removal of the thickened edematous scrotal mass, with plastic formation of a new scrotum and penile covering, is the only treatment. Owing to the regenerative powers of the scrotal tissue, healing and a return to approximately normal conditions may be anticipated even if the greater part of this structure be excised. When the inguinal glands are enlarged they should be dissected out. Sometimes unilateral castration may be required if the testicle is involved in the brawny enlargement. Often, however, the testicles are unaffected, and a careful plastic intervention will restore the scrotum to practically its normal condition.

No known drug has proved efficient in eliminating the parasite from the blood, but in a majority of the cases excision of the blocked lymphatics seems to eliminate the filaria with the affected tissues, so that complete recovery has been reported following surgical excision in a considerable number of cases. If the enlargement is trifling when the patient is first seen, it may be well to elevate the genitals so as to protect them from injury, and delay operation until there is sufficient evidence of a progressive enlargement. Excessive swelling and induration usually cause the patient to seek relief because of interference with sexual function and micturition.

Ascertainment and early removal of the cause are, of course, neces-

sary in the acquired non filarial types Palliative measures are indicated during exacerbations of lymphangitis, and antiluetic treatment in the syphilitic cases

### *Benign Tumors of the Scrotum*

Benign tumors of the scrotum have little clinical importance since they rarely attain a large size and seldom become malignant Sebaceous and atheromatous cysts are the most common Cases of hemangioma, lymphangioma, lipoma, fibroma, and chondroma have been reported Treatment of benign scrotal tumors is usually excision

#### LIPOMA OF THE SCROTUM

The scrotum is only rarely the site of fatty tumors Lipomas are occasionally encountered and may attain a considerable size Cecil's review of this subject, published in 1927, contains an extensive bibliography of earlier reports but fails to mention the monograph of Dubinsky (1916) This is a study of about 50 cases, and gives many valuable observations on etiology and pathological anatomy

**Etiology** It is difficult, even upon pathological examination of the excised specimen, to determine in what part of the genital canal lipomas originate They supposedly arise from fat elements in the cord but by the time they come under medical observation they have usually attained such size that a tumor originating in the spermatic cord will have pushed its way through the tunica vaginalis to mingle with the sub peritoneal fat, or a growth arising in this fat layer will have progressed downward into the scrotum In either event, it may be impossible to determine the precise point of origin

**Diagnosis** Scrotal lipomas are most often seen in men in the fifth to seventh decades of life Neither the adolescent nor the aged seems to be affected

Differential diagnosis is not always easy Although fatty tumors are sufficiently characteristic in feel and appearance to enable an experienced observer to identify them readily, there is, nevertheless, danger of confusion with hernia and the ever present possibility of a hernia being present within the fat mass itself

**Prognosis** After surgical removal the growth sometimes recurs, but this is the exception rather than the rule

**Treatment** Treatment is surgical excision Even if the testicle is not actually included in the mass, its blood supply may be so closely

associated with it as to make orchidectomy necessary. Every effort should be made to avoid this. Bonney operated upon the right side of the scrotum of a man from whose left scrotum a seven pound tumor had been removed (with the testicle) 15 years earlier. Although the tumor

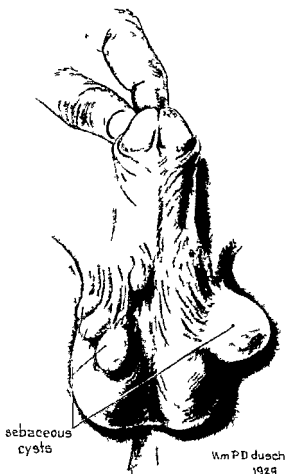


FIG. 81 Sebaceous cysts of the scrotum resulting from clogging of the oil ducts in the skin with subsequent dilatation of the sebaceous glands from retained secretion. They may occasionally become enormous but are usually about the size shown here. There is no grave danger in this lesion but it is very disturbing to the patient mentally.

was adherent to all the surrounding structures; enucleation was accomplished without sacrifice of the testicle.

#### SEBACEOUS CYSTS

Sebaceous cysts of the scrotum are relatively common as might be expected from the abundance of sebaceous glands in the scrotal skin.

They are due to dilatation of the sebaceous glands from retained secretion, and may be single or multiple. They are yellowish, rounded, and firm, and vary in size from the very minute to about the size of a large marble. There are no symptoms unless the cysts become infected, when they become tender and the surrounding skin reddened.

An interesting case of multiple sebaceous cysts in a recruit examined during World War I was reported by G. A. Gray in 1918. The patient was 25 years of age and had first noticed a cyst upon his scrotum when he was about 15 years old. The lesion started as a small yellowish red swelling near the top of the scrotum. This slowly increased in size. Soon other cysts developed and at the end of a year there were 7 on the right side of the scrotum and 8 on the left. Other growths subsequently made their appearance until there were 114 cysts of varying sizes. Most of the growths gave no symptoms of any kind but a few broke down, with a typical discharge. The patient's health was unaffected and the condition was not regarded as a disqualification for service in the United States Marine Corps. At various times during the preceding 10 years this man had had identical lesions upon his face and left elbow, which had been removed as they appeared.

Calcified sebaceous cysts of the scrotum are discussed on page 432.

**Treatment.** Treatment is usually not required unless the cysts become inflamed. Extirpation *in toto*, including the entire cyst wall, is the treatment of choice.

### *Malignant Neoplasms of the Scrotum*

Tumors of the scrotum—that is, of the scrotal skin, dartos, and connective tissue—are of infrequent occurrence and have received scant consideration in the literature. The only one of any practical importance is the epithelioma which occurs in workers with tar products, mineral oil, and chimney soot. There have been scattered reports of sarcoma of the scrotum, but the condition is extremely rare.

### EPITHELIOMA OF THE SCROTUM

Epithelioma of the scrotum, the so called "chimney sweep's cancer," today occurs more frequently among workers in mineral oil, paraffin, and tar than in chimney sweeps, and is much more common in England than in the United States. It is now generally regarded as an industrial disease, and is preventable.

**Etiology.** The peculiar liability of chimney sweeps to epithelioma of the scrotum has long been an observed fact in England, and has been

attributed to the irritant action of the soot plus friction from clothing. In 1892 Butlin reported 48 cases of epitheliomatous ulceration 34 of which were in chimney-sweeps. But, as England is by no means the only country where "sweeps" are employed in considerable numbers, the comparatively high incidence among English sweeps has always lacked an adequate explanation.

More recently it has been established, both here and abroad that prolonged exposure to tar and its products tends to produce ulceration of the skin, particularly that of the scrotum. Of 141 cases of scrotal cancer admitted to the Manchester (England) Royal Infirmary from 1902 to 1922, only 1 occurred in a chimney sweep. Twenty-two were in workers in tar or paraffin. The majority of the patients however were mule spinners in the Lancashire cotton mills and investigation showed that men thus occupied were constantly exposed to the irritating effect of lubricating oil and slight but constant trauma upon the left anterior aspect of the scrotum from contact with the moving carriage of the machine. In the mule spinner, at least, the etiology of epithelioma of the scrotum appears to depend on chronic irritation, the result of friction and contact with oil. Recent reports of spinner's scrotal cancer have been fairly numerous. These conditions are by no means confined to English workmen and similar investigations in this country might prove of interest.

The high percentage of scrotal epithelioma in workers in tar, paraffin mineral oils and soot indicates that constant contact of the scrotum with these substances, plus friction from clothing is the etiological factor. All workers in tar or paraffin, and those exposed to contact with oil and soot upon particularly sensitive cutaneous areas, such as the scrotum, should be cautioned to exercise special prophylaxis of these parts.

**Pathology** Epithelioma of the scrotum usually begins as a small wart like excrescence, which may persist as an apparently benign soft warty outgrowth for a long time before coming to a head which when removed, leaves a pigmented eczematous patch that later extends and assumes the well recognized appearance of a carcinomatous ulcer. The inguinal glands usually become enlarged at this stage but the local ulcerative process progresses very slowly. In the third stage—that is, when the lesion assumes the form of an epitheliomatous fissure—extension is more rapid and there is involvement of the deeper tissues. The malignant glands tend to ulcerate and break through the skin. Metastasis to distant organs is uncommon.



**Diagnosis** The history, particularly that portion of it relating to occupation, is most important. The macroscopic appearance of the lesion is usually sufficient to differentiate it from other scrotal lesions, such as gumma and sebaceous or dermoid cysts. The diagnosis is made upon *microscopic examination of a biopsy specimen*.

**Treatment** Surgery is the treatment of choice in scrotal malignancy, and can be carried out with safety and success in a high percentage of cases. The scrotal skin is so loose that even a wide excision permits the edges to be drawn together and healing by first intention secured. Most patients prefer this, as the suffering and hospitalization are brief and less taxing than a course of radiation. With radiation there is also the possibility of sterilizing the patient if the testicles are not properly protected from the effects of the rays. As epithelioma of the scrotum quite frequently occurs in comparatively young men, this is a serious consideration (Radium and Roentgen Ray Therapy of the Genito Urinary Tract, p. 1736).

Radical removal of the scrotal growth, with extirpation of the glands in both groins, is indicated in almost every case. Even in the early innocent appearing "wart" stage the growth appears to be definitely malignant, and involvement of the glands is prone to take place early. It is, therefore, of great importance that all possible areas of malignancy be dissected out and the inguinal region cleared of all foci of recurrence.

The growth in the scrotum should be excised with a wide margin of healthy tissue, the whole thickness of skin and dartos being removed and the glands and adjacent fat in both groins fully extirpated. Anastomosis between the superficial lymphatics on both sides is very free, and if the growth reaches the median raphe metastasis to either groin is likely to occur. We prefer to remove the scrotal growth and the tissues of the groin through separate incisions. *The best incision for removing the glands is one parallel to and below Poupart's ligament, extending from the anterior spine to the spine of the pubis, from the center of this a vertical incision is carried a short distance down the thigh. This incision allows a good exposure of the infected tissues and their easy removal.* Some surgeons prefer to remove the scrotal tissue and glands in one mass.

#### *Calculi and Concretions*

Occasional reports of scrotal calculi have appeared in the literature. They are either (1) calcified hematomas, (2) urinary calculi that have

ulcerated through the urethral wall or (3) calcareous deposits in an old urinary fistula Gessner reported a case of calcified scrotal hematoma which, on sectioning was found to present a calcareous shell enclosing cholesterol crystals and red and white blood corpuscles

**Treatment** Treatment is surgical removal

### *Calcified Sebaceous Cysts of the Scrotum*

Medical literature contains infrequent reports of calcification of scrotal cysts as well as the condition designated *calcinosis cutis* The first report appears to be that of Lewinski (1883) Cooke (1928) found 9 reports in the literature to which he added a case of his own These do not include the case illustrated by us in a previous publication

**Etiology** The reason for the deposit of calcareous material in the skin of the scrotum is obscure It is supposedly due to some error in calcium metabolism or to a primary local change in the connective tissue Endocrine imbalance has also been suggested as a possible etiological factor

**Pathology** The typical lesion consists of a mass of powdery calcareous material enmeshed and surrounded by fibrous tissue In Tate and Trumper's case the scrotum was covered with small tumors especially on the right side where they presented an appearance something like a bunch of grapes The usual history is of painless lumps in the scrotal skin frequently of long duration which cause no inconvenience until they increase greatly in size and as sometimes happens break down, exuding a powdery material

**Prognosis** Healing following surgical removal in the reported cases was usually prompt but recurrence nearby was the rule In our case the cysts were dissected out and as long as the patient was followed there had been no recurrence In another case (Cooke) four of the largest lumps were removed followed by prompt healing of the incisions but 30 months later the smaller cysts which had been left undisturbed had increased considerably in size

**Treatment** The advisability of surgical removal will have to be decided by the individual surgeon and patient Acting upon the hypothesis of a disturbance in calcium metabolism an effort to correct this by dietary or other measures might be effective in preventing recurrence following surgical excision

## 2 Diseases of the Scrotal Contents

*Orchitis*

Orchitis occurs much less frequently than epididymitis, because the epididymis serves as a trap for infectious organisms, thereby protecting the more important structure

**Etiology and Bacteriology** *Chronic Orchitis* Chronic orchitis manifests itself clinically in two forms only the tuberculous (p 440), which is almost always an extension from the epididymis, and the syphilitic (p 445)

*Acute Orchitis* Non specific infections of the testicle, epididymis, or both, producing an acute orchitis, epididymitis, or epididymo-orchitis, are common

Acute orchitis is either (1) an ascending infection from the posterior urethra through the lumen of the vas deferens and the epididymis, (2) an epididymo-orchitis, or (3) a metastatic infection, the infective organisms gaining entrance to the testicle by way of the blood and lymphatic systems "Traumatic orchitis" is a misnomer, such inflammations being either ascending or metastatic in type, even though secondary to trauma

Almost any organism may enter the testicle through the blood, producing an acute orchitis or epididymo-orchitis The organisms most commonly found are the *Bacillus coli communis* and the *Staphylococcus aureus*, but the gonococcus *Bacillus lactis aerogenes*, various streptococci, the pneumococcus, *Bacillus mucosus capsulatus*, and *Bacillus pyocyaneus* have all been reported

Acute orchitis may follow infection from the seminal vesicles, the urethra, or the bladder, but under these conditions the epididymis will usually also be involved Infection may be carried to the testicle during the course of a pyemia or an infectious disease such as typhoid, paratyphoid, or typhus fever, diphtheria, scarlet fever, mumps, influenza, acute articular rheumatism, gout tonsillitis, malaria, filariasis, glanders, and pneumonia Orchitis may also occur as a complication of a localized focal infection, such as sinusitis apical abscess, osteomyelitis, cholecystitis and appendicitis Though rare, spontaneous or idiopathic orchitis occasionally occurs with pyogenic cocci in an otherwise apparently healthy person causing not only acute local symptoms but profound constitutional disturbance as well

**Pathology** While no age is exempt, both orchitis and epididymitis are most frequently encountered during the years of greatest sexual activity

The patient may apply for treatment of an acutely inflamed testicle, or complaint of the testicle may be made during the course of some other affection. Examination will show the gland to be hard, tense, and enormously swollen. There is generally exudation into the tunica vaginalis. The suppurative process may involve the whole testicle in which case orchidectomy will be necessary, but a single abscess, or multiple abscesses scattered over its surface, is more common. Larger abscesses are formed by coalescence of smaller ones. As a rule, suppuration is confined to the testicle but in rare instances the pus burrows through the tunica vaginalis and invades surrounding tissues.

*Microscopically*, round cell infiltration, with great leukocytosis, and marked edema are prominent in the interstitial portion of the gland. The tubules do not usually show these characteristic inflammatory changes to the same extent, although a few polymorphonuclear leukocytes may be found within them. *Round-cell infiltration and edema* invade the fibers of the tunica albuginea, sometimes pushing them widely apart.

*Orchitis of Mumps*. The incidence of a complicating acute orchitis is greater with parotitis than with any other infectious disease with the exception of variola. This subject which has not received the attention that its prevalence, severity, and far reaching effects warrant was fully discussed some years ago by Wesselhoeft whose statistical material (mostly military and naval) gave him an incidence of 18 per cent of cases of mumps in the male which developed orchitis. Other authorities have placed the percentage much higher. In infants and little boys with parotitis this complication is very rare, but in adolescence and early manhood the chance of a testicular involvement is greatly increased.

*Atrophy of the testicle* occurs in more than half of the cases. Fortunately, the testicular infection is not ordinarily bilateral.

In the majority of cases the orchitis appears from 3 to 7 days after the parotitis has reached its height, but it may occur at any time, even as late as the third week.

*Symptoms and Diagnosis of Acute Orchitis*. The onset of acute orchitis is usually sudden and is accompanied by a sharp rise of temperature, chills, headache and pronounced weakness. These may be followed by diarrhea, nausea, vomiting, and, occasionally, delirium. The blood picture is that regularly found when suppuration exists anywhere in the body. The pain in the testis varies from a slight discomfort and sense of weight to excruciating pain radiating to the perineum, thigh, inguinal

or sacroiliac region, or even to the abdomen. The testicle swells rapidly, *often quadrupling its normal size*, and is firm and sensitive on palpation. The skin of the scrotum is red, edematous, and sensitive to the touch. The epididymis and spermatic cord may be involved in the inflammatory process, the epididymitis being frequently accompanied by formation of hydrocele.

It is often difficult to differentiate an acute orchitis from torsion of the cord, strangulated hernia, or acute epididymitis. Torsion may, indeed, precede orchitis, for interference with the testicular circulation will set up a necrotic condition offering a fertile soil for bacterial invasion. If the acute condition complicates an infectious disease it is most likely an orchitis. The presence of a hydrocele may make differentiation by palpation impossible.

**Prognosis of Acute Orchitis.** The prognosis is always good so far as the life of the patient is concerned, but atrophy of the testicle is common, particularly in cases of mumps. The chances of saving the testicle are, however, good if proper treatment is instituted early.

**Treatment of Acute Orchitis.** Treatment should be expectant at first, and consists in elevation of the scrotum and the use of hot or cold applications (Non Operative Treatment of Orchitis and Epididymitis, p. 517). Surgical intervention is indicated as soon as fluctuation and suppuration are noted. *If the entire testicle is involved, simple incision and drainage may not suffice and orchidectomy may be necessary.*

Even in severe cases of the orchitis of mumps, palliative treatment is usually all that is necessary unless suppuration sets in. Some clinicians, however, advocate multiple incisions of the tunica albuginea during the height of the infection, in the belief that relieving the tension will restore the circulation and prevent later atrophy of the gland, which they regard as due to the increased intratesticular pressure caused by the inflammation. To be effectual, such intervention must be undertaken early. Others believe that the likelihood of orchitis in mumps is reduced by injecting 20 cc. of diphtheria antitoxin.

Testicular atrophy occurs most frequently after an attack of orchitis due to mumps, and practically always in patients beyond the age of puberty. It is most important, therefore, that an adolescent or adult patient with mumps be kept in bed, as this treatment has been found to be most efficient in the prevention of orchitis and its oftentimes serious consequences.

*Epididymitis*

Epididymitis is due to bacterial invasion of the epididymis, and occurs much more frequently than does orchitis. The commonest cause of epididymitis is the gonococcus, but the epididymis is also subject to tuberculous infection (p 440), syphilis (p 445), and various non specific infections.

## GONORRHEAL EPIDIDYMITIS

**Etiology** Invasion of one or both epididymis by the gonococcus is a frequent complication of gonorrhea involving the posterior urethra, and often produces occluding changes which render the patient sterile (Gonorrhea in the Male, p 701). The commonly accepted explanation is that the inflammation ascends from the urethra up the ejaculatory duct and along the vas deferens extending to the lymphatics of these structures. Thus, any patient harboring a chronic posterior urethritis stands in danger of recurrent attacks of epididymitis, for a multitude of exciting factors such as unwise or too vigorous instrumental or manual manipulation, violent exercise, indulgence in alcohol, or sexual excitement may produce urethral irritation and set up an inflammatory condition in the epididymis. Prevention of posterior urethritis eliminates the danger of epididymitis.

**Pathology** Invasion of the epididymis by the gonococcus is first manifested as a rule by a small swelling in the globus minor. This rapidly increases in size until, ultimately, the entire epididymis is involved in the inflammatory process. Often punctate abscesses are present, which may coalesce and the whole organ become a necrotic mass. In the majority of cases the testicle escapes but the vas deferens is usually involved and may be enlarged from its normal 1-cm thickness to thrice that size. Small abscesses sometimes form within it.

**Microscopically**, there are observable all the evidences of an acute catarrhal inflammation: desquamation of epithelium, the presence of numerous infiltrating polymorphonuclear leukocytes and great edema of the tissues. The seminiferous tubules frequently show minute focal abscesses. Tubular occlusion by cellular debris, leukocytes, and edema is common. Puncture of the epididymis in the acute stage shows frank pus, neisserian organisms being readily demonstrated in most cases.

**Symptoms** Pain is the outstanding symptom ordinarily. For a day or so before the appearance of the epididymal swelling there may be inguinal discomfort, pain along the cord and a localized ache or sharp

stabbing pain in the epididymis. Sometimes the symptoms are quite mild, and complete rest, with elevation of the scrotum, may be all the treatment needed to clear up the acute symptoms. More often, however, there is fever and the pain becomes increasingly severe, and may be referred to the lower back, rectum, or the lower abdominal region. Motion exaggerates the discomfort, and walking may be impossible. The affected organ is acutely sensitive to pressure and swelling is marked.

The usual clinical course of acute gonorrheal epididymitis is one of an abrupt onset with gradual decline over a period of 3 to 5 days after institution of proper treatment. In some cases symptoms may be almost entirely absent from the onset and the patient may be aware merely of a slight local swelling. This is unusual, however, and ordinarily the onset is violent, with exquisite pain in the epididymis, accompanied by chills, fever, nausea, prostration, and, in rare cases, collapse.

**Diagnosis** As a rule the diagnosis is easily made by finding an acute inflammatory process involving the epididymis in the presence of a urethral discharge. Detection of the gonococcus in the urethral secretion establishes the cause of the disease. The greatly swollen, red, tender scrotum, and the epididymis enlarged first at the globus minor and then throughout its entire extent, constitute a characteristic and well known clinical picture. The epididymitis is only part of the gonorrheal complication. The prostate and seminal vesicle are usually involved and the vas deferens tender and enlarged.

**Differential Diagnosis** Gonorrheal epididymitis must be differentiated from tuberculous, syphilitic, and non specific epididymitis. This is best accomplished by palpation. Gonorrheal epididymitis is characterized by a red, hot, swollen, and tender organ. In tuberculous infection the organ is swollen but not tender, and is usually nodular, the vas giving one the impression of palpating a string of beads. The syphilitic epididymis assumes a clam shell shape as it overgrows the testicle. It is not tender, red or hot, and the vas is not usually involved. Torsion of the cord may simulate acute gonorrheal epididymitis. So, too, may non specific infections of the epididymis, but the absence of gonococci and of a history of gonorrhea will help to distinguish these.

**Prognosis** A single acute attack of gonorrheal epididymitis usually subsides in a week or two, and is often too lightly regarded by both physician and patient. Relapse is very likely to occur in gonorrheal

as in other types of epididymitis, and the acute attack may gradually subside into a chronic condition. In the gonorrheal form a fresh infection may at once set up a new inflammation, but in many men repeated new infections never reproduce the epididymal complications.

Death rarely follows acute gonorrheal epididymitis, although a few instances of septicemia have been reported. The morbidity is high, however, and sterility results in about 50 per cent of the bilateral cases, due to occlusion of the convoluted tubules of the epididymis by the healing process following inflammation thus cutting off communication between the testicle and seminal vesicle.

**Treatment** *Palliative* The general tendency in treatment is toward conservatism. Palliative measures are of first importance in acute epididymitis. These are described under Non Operative Treatment of Orchitis and Epididymitis (p. 517). The reader is also referred to the section on the treatment of gonorrhea in Chapter XXII Gonorrhea in the Male.

*Surgical* Operative intervention is sometimes necessary for suppurative or recurring cases and consists of puncturing the epididymis through the skin (a procedure of considerable merit) or open operation, with multiple scalpel punctures and drainage (Epididymotomy, p. 500). Rarely does the surgeon find it advisable to remove the epididymis in an acute inflammatory condition.

#### NON SPECIFIC EPIDIDYMITIS

Non specific (pyogenic) epididymitis is the term applied to an inflammation of the epididymis caused by organisms other than the gonococcus, *Spirochaeta pallida*, and tubercle bacillus.

**Etiology and Pathology** Non specific infections of the epididymis are relatively common. The organisms chiefly responsible are the staphylococcus and the colon bacillus—less often the *Bacillus lactis aerogenes* and various streptococci. A non specific infection may arise in the course of a gonococcal epididymitis.

Bacterial invasion of the epididymis is by way of the blood and lymph streams and the vas deferens. Hematogenous infections are rare, are usually associated with orchitis, and may be metastatic from a localized focal infection in the tonsils, teeth, sinuses, etc., or a complication of some infectious disease such as typhus fever, influenza, mumps, or malaria. The common non specific epididymitis is ascending by way of the vas deferens.

Non specific infections of the epididymis may be *acute* or *chronic*. The



acute forms may become chronic, but there is a chronic form which comes on insidiously without showing an acute stage

*Acute Epididymitis* Acute non specific epididymitis is usually ascending and secondary to an infection in the urethra, prostate, or seminal vesicle. Occasionally the epididymitis may appear to arise spontaneously, independently of any known antecedent lesion, but subsequent examination will usually reveal a non specific infection elsewhere in the urogenital tract

Involvement of the epididymis in a lower tract infection may be incited by sexual excess, alcohol, or physical exertion. Acute non specific epididymitis may be secondary to urethral instrumentation, rectal palpation, or too vigorous massage and stripping of the prostate and vesicles. In the majority of these cases infections of the lower tract exist

The pathological changes in the epididymis are very similar to those in gonorrheal epididymitis. As a rule, the globus minor is first involved, the pathological changes being chiefly intratubular. There is desquamation of the epithelium lining the lumen of the globus minor, great edema, and the lumen itself is filled with a purulent exudate. Later the infection spreads to the body and globus major, chiefly by interstitial extension. With healing, scar formation often produces permanent occlusion. There is a tendency to the formation of abscess, either in the epididymis or at the external abdominal ring

*Chronic Epididymitis* Simple chronic epididymitis may follow an acute attack, but often comes on insidiously, without any history of an acute epididymitis or antecedent urethral lesions. The inflammation begins as an inflammatory nodule in the globus minor, chronic in nature, of only slight tenderness and causing no constitutional disturbance. There is usually an irregular induration of the vas and seminal vesicle or prostate. Small chronic abscesses sometimes develop, which may rupture and produce scrotal fistulas. The lesion resembles and often passes for tuberculosis until, quite spontaneously, it frequently disappears, leaving a scarcely perceptible thickening of the vas

*Symptoms* The symptoms of an acute non specific epididymitis are similar to those described under gonorrheal epididymitis, although not usually so severe. The symptoms of the chronic pseudotuberculous type resemble those of tuberculous epididymitis

*Diagnosis* Non specific infections are likely to offer diagnostic difficulties even to the most expert. The fact that a non specific infection may be coincident with a gonorrheal epididymitis increases the difficulties of diagnosis, for under such conditions even a positive complement-

fixation test is not proof that the epididymitis is of gonococcal origin. Clinical differentiation of simple chronic epididymitis from tuberculosis may be impossible. Non specific infections tend to disappear spontaneously, while tuberculosis is essentially chronic. The microscope is the only positive test. These pyogenic infections must be differentiated from syphilis and tumor as well as from tuberculosis. Syphilis is readily recognized by the clam shell like enlargement of the epididymis and by serological tests. Tumor may be differentiated in some instances by the hormonal test.

**Prognosis** Non specific epididymitis is generally less severe than gonorrheal infection. Death has never occurred in our series. The morbidity and serious consequences, however, demand early recognition and treatment. Such infections often occlude the epididymal canal and lumen of the vas and when bilateral result in a high percentage of total sterility. Relapse is more likely to occur than in gonorrheal epididymitis. Frequently the acute attack subsides into a chronic condition the epididymis never regaining its normal state.

**Treatment** Treatment is usually palliative and in general, is similar to that described above for gonorrheal epididymitis: rest in bed, elevation of the scrotum and hot or cold applications. Intravenous protein therapy, sulfonamide therapy and diathermy are often efficacious. Suppuration requires prompt and thorough drainage. Operative intervention may also occasionally be necessary for the relief of tension. Just as chronic prostatitis and seminal vesiculitis are sometimes definite factors in maintaining a chronic inflammation of the epididymis so also the reverse may be true and chronic epididymitis will maintain a chronic prostatitis and vesiculitis. Epididymectomy may be indicated under such circumstances.

### *Tuberculosis of the Testicle and Epididymis*

Koch's bacillus frequently attacks the epididymis, but rarely the testicle. When tuberculosis does invade the testicle the testicular lesion is practically always secondary to that of the epididymis.

**Etiology** Whether the original focus is in the epididymis or in the prostate and seminal vesicle is a matter of controversy. One group of observers maintains that the lesion begins in the epididymis and descends to the vesicle and prostate and thence to the opposite vesicle and epididymis. Another group ascribes the seminal vesicle or prostate as the site of the primary lesion the infection spreading by ascension to the epididymis and later to the opposite vesicle and epididymis.

Autopsy records show that a tuberculous lesion may be limited to the epididymis, seminal vesicle, or prostate, but that such limitation is relatively rare. Usually, combined lesions of these structures occur, and it may be impossible to judge in which organ the process commenced. Mistaken conclusions as to priority are easily drawn because the lesion which appears to be the more advanced is not necessarily the primary or older one.

The general opinion that genital tuberculosis is primary in the epididymis is no doubt due partly to the fact that the epididymal involvement is an obvious lesion, while prostatic and vesicular tuberculosis is easily overlooked and may remain undetected even on rectal palpation. Barney, after carefully following 154 personal cases and thoroughly reviewing the literature, concluded that the epididymis is the primary focus in the majority of cases.

In support of the belief that the primary focus is in the prostate or seminal vesicle, K. M. Walker has pointed out (1) that while it is *extremely rare to find tuberculosis of the epididymis without some indication of disease of the prostate or vesicles*, tuberculosis of the prostate is not infrequently found unaccompanied by disease of the epididymis, (2) the appearance of a tuberculous epididymitis is often preceded by symptoms of prostatitis or vesiculitis, (3) when tuberculosis of the epididymis occurs together with tuberculosis of the prostate, the lesions in the prostate generally have the appearance of being older than those in the epididymis, (4) the earliest signs of tuberculous disease are found at the lower pole of the epididymis which is the first position opposing the line of march of the invading organisms, (5) tuberculous nodules in the lower pole of the epididymis usually appear older than those in the upper pole, and are the first to soften and break down, (6) tuberculous epididymitis ordinarily has no analogy to the hematogenous orchitis of mumps but is analogous to acute infections which are known to have been produced by extension from the urethra.

Hugh H. Young, from a large surgical experience and an exhaustive review of the literature, concluded that most cases of genital tuberculosis are primary in the seminal vesicles and proposed 'tuberculosis of the seminal tract' as appropriate.

Our own clinical experience inclines us to the belief that in the majority of cases tuberculosis of the genital tract is primarily epididymal and hematogenous in origin.

As a rule, genital tuberculosis can be traced to a focus elsewhere in the body. This focus is most frequently in the lung—infections of the

kidney and bone being next in frequency. Less common foci are those in the joints glands larynx, middle ear peritoneum and ischiorectal fossa. It is rarely, indeed, that a primary focus outside the genital tract cannot be found either clinically or at autopsy.

**Pathology** Tuberculous epididymitis usually manifests itself first in the globus minor. Ordinarily it begins as a subacute practically painless process which may have existed for some time before the patient regards it as of sufficient importance to consult a physician. Not infre-



FIG. 82 Photomicrograph of advanced tuberculous of the epididymis. Many tubercles are clearly seen. Giant cells are scattered throughout the field.

quently, however, there will be an acute attack simulating gonorrheal epididymitis; indeed the demonstration of a mixed infection in such cases is not uncommon. The developing tubercles form hard masses which soon extend from the globus minor throughout the extent of the epididymis. The vas deferens will be found nodular and thickened. In certain cases the process may remain quiescent for a long time, bursting forth now and again with surprising violence, all the while replacing the normal tissues by a process of caseation and cicatrization. Hydrocele develops from the distention of the tunica vaginalis by fluid in the tubercles with which it is studded.

*Tuberculosis of the testicle* is almost always secondary to tuberculosis of the epididymis, and manifests itself first in the corpus. Highmore Authorities differ as to whether the tubular system or the connective tissue is first affected in the lymphogenous type of tuberculosis seen clinically. Barney's studies indicate that the process is, in general, intertubular, that active spermatogenesis continues even in advanced destruction of the testicle, but, despite this, there is early azoospermia, showing that the vas must be occluded early and adding to the evidence supporting extensive involvement of the prostate or vesicles in epididymal tuberculosis. The testicle may show a single large focus, or multiple foci throughout or in small areas. By extension and coalition the entire testicle becomes a caseous mass. On the other hand, the tuberculous process in the epididymis often assumes extensive proportions and the testicle will be found as a small, compressed organ, free from involvement.

Eventually, the scrotum becomes adherent and the process ulcerates through, forming a chronic fistula through which is discharged the caseous material resulting from the breaking down of the tubercles. A sinus connecting with the epididymis is most likely to be situated on the posterior aspect of the scrotum, one connecting with the testicle will probably be found on the anterior surface. The function of the affected organ is practically always destroyed, and, should the process become bilateral, complete sterility is inevitable.

*Microscopically*, the tissue resembles tuberculosis seen elsewhere in the body, small and large tubercles with characteristic giant cell formation being observed.

Often the disease is apparently bilateral from the onset. When tuberculosis infects one epididymis, the opposite epididymis is likely to become involved sooner or later, usually within a year, either by ascension through the vas deferens from the prostate or seminal vesicle, or by way of the blood stream. Involvement of the opposite side, however, has been known to be delayed as long as 8 years.

**Symptoms and Diagnosis** The first step in diagnosis is a careful history. Most of the patients are in the third decade of life—seldom over 45 or under 15 years of age. There will usually be a history of trauma or preceding gonorrheal epididymitis and, in many cases, a personal or family history positive for, or at least highly suggestive of, tuberculosis. Most patients seek treatment within 6 months of the supposed onset of the disease. Loss of weight and general malaise are common complaints. So, too, are abnormal urine and symptoms referable to the bladder, such as frequency and burning on urination, urgency,

pyuria, and hematuria. Occasionally the first and only symptoms are those referable to the bladder. Fever is rare. Pain and tenderness are generally mild and intermittent or absent, unless the attack is acute, when the pain will be more severe and accompanied by swelling of the gland. The pain is local or radiates to the groin or lumbar region. Sexual desire and potency are rarely impaired but azoospermia occurs early.

A history of exacerbations and remissions is common and one of hydrocele with frequentappings, or of scrotal abscess resulting in formation of a sinus, is not infrequent.

Physical examination should include a careful search for a primary focus outside the genital tract as the character of the primary focus has an important bearing on the treatment. Palpation of the epididymis will yield a "lumpy" sensation. The vas deferens will likewise be indurated and nodular while rectal palpation will show a similar condition in the prostate and seminal vesicle in a large percentage of cases. These findings, together with the age and the pertinent facts in the history, are often sufficient to establish the diagnosis.

An important anatomical consideration is the fact that the lymphatics of the testicle and epididymis drain up to the original site of the testicle at the hilum of the kidney, thus establishing a connection with that important organ. Many authors believe that tuberculosis of the kidney may be secondary to lesions of the epididymis on the same side, hence the diagnosis of tuberculous epididymitis is most important and its elimination imperative.

*Differential Diagnosis* While at times easy, the differential diagnosis is not infrequently taxes all our diagnostic resources. Tuberculous epididymitis may easily be confused with inflammation due to other causes. Bilateral epididymitis slightly favors a diagnosis of tuberculosis. A prior epididymectomy or orchidectomy almost invariably points to tuberculosis, as does a persistent scrotal fistula. It has been proved that in over 90 per cent of patients with evidence of tuberculosis elsewhere in the body the diseased epididymis was tuberculous. Careful physical examination including rectal palpation of the prostate and seminal vesicles is therefore of the greatest importance in the differential diagnosis of scrotal swellings. If definite involvement of the prostate and vesicles can be established there is every possibility that the epididymal process is tuberculous.

The age incidence and the duration of the disease are of no value in differentiating between tuberculous and non tuberculous inflammations.

of the epididymis and testicle Neither is a history of trauma or previous gonorrhea and acute epididymitis, nor the finding of an enlarged, thickened, or nodular vas deferens, as these frequently occur in both groups

A syphilitic process almost always makes its initial appearance in the testicle, whereas tuberculosis is first clinically evident in the epididymis Syphilis involving the epididymis alone is rare, and may be differentiated by the history, negative rectal findings its preference for the globus major, and by the Wassermann test Syphilis and tuberculosis may, however, coexist

*Tumors of the epididymis* are rare, but, when present, may complicate the diagnosis Cysts (spermatocele) are more common, but are rarely confusing Testicular tumors sometimes offer difficulties The hormonal test is of diagnostic help in some cases of tumor

**Prognosis** The high morbidity in genital tuberculosis, even when properly treated, is not generally appreciated The disease is progressive and fairly rapid in its evolution Various authors have placed the ultimate mortality at from 27 to 60 per cent Ten years or more must elapse before the danger is past

**Treatment** We favor prompt operation as soon as a diagnosis of tuberculosis of the epididymis has been made (1) because by prompt removal of the epididymis, involvement of the testicle by direct extension is prevented, and (2) because dissemination to the kidney on the same side and to the epididymis on the opposite side is thereby prevented

The radical operation—that is, removal of the epididymis, vas deferens, and seminal vesicle of the affected side—should be done when indicated (Radical Removal of the Genital Tract for Tuberculosis, p 510) Ordinarily, however, the conservative operation—simple epididymectomy, with transplantation of the vas to the skin of the groin, to prevent tuberculous pus from flowing into the scrotum (pp 502 and 504)—is the operation of choice

Here, as in all cases of urogenital tuberculosis the operation is merely the beginning of the treatment Every postoperative case should be given careful hygienic treatment, including graduated injections of old tuberculin heliotherapy, and other physiotherapeutic, as well as dietary measures (Treatment of Inoperable and Postoperative Urogenital Tuberculosis p 1196)

#### *Syphilis of the Testicle and Epididymis*

Syphilis attacks the testicle much more often than the epididymis Syphilis of the epididymis alone, without involvement of either the

testicle or the spermatic cord is rare. Luetic orchitis is found in both congenital and acquired forms of syphilis and may occur as diffuse interstitial orchitis or a gumma. The epididymis may be involved by direct extension from the testicle. The lesion is essentially chronic.

According to Herman and Klauder the testicle and the bone marrow contain the *Treponema pallidum* before the appearance of the chancre. Warthin demonstrated the spirochete repeatedly in testicles presenting no gross lesions and in cases of congenital and acquired syphilis he found them in testicles devoid of histological lesions. Autopsies of syphilitics show that aside from the heart and aorta the testicles are most frequently involved and that chronic fibrous orchitis is an almost constant finding in those affected with paresis.

**Pathology** Though clinically demonstrable in but a small number of cases pathologically the testicles of practically every syphilitic may be said to be diseased. These pathological changes tend toward a progressive decrease of spermatogenesis which may progress to a premature loss of sexual desire and sterility. In syphilitic orchitis the pathological changes are essentially microscopic and belong to the tertiary stage. They are characterized by a chronic interstitial fibrosis with or without gumma.

Histologically there exists in active cases of syphilitic orchitis a plasma cell and lymphocytic infiltration between the tubules about the smaller vessels a proliferation of endothelial cells from the capillaries and fibroblasts of the stroma with thickening of the basement membranes and decreased spermatogenesis. Such changes may be diffuse or local. In localized orchitis areas of healthy functioning tubules are found. In late stages the intertubular stroma is thickened and hyaline or the entire testicle may be fibrous.

Grossly the involved organ may be enlarged globular indurated and smooth. If fibrous it is smaller and of harder consistency. In less pronounced cases the testicle may be normal in size but induration is a persistent feature.

**Gumma** though relatively rare in syphilitic orchitis occurs often enough to be an important factor in the differential diagnosis of testicular pathology. Gumma may be single or multiple. The testicle is enlarged rounded nodular or smooth heavy and insensitive to pressure though there may be painful sensations in the organ due probably to traction on the cord or distention of the adjacent tissues. Adhesion to the scrotum is not uncommon. Gummas sometimes break down and discharge caseous matter in which event secondary infection and abscess



formation are likely to follow, with, eventually, ulceration through the scrotum and hernia of the testicle. The breaking down may be followed by formation of a chronic sinus. Hydrocele frequently accompanies gumma of the testicle.

*Syphilis of the epididymis* occurs as an acute or chronic interstitial epididymitis or as a gumma.

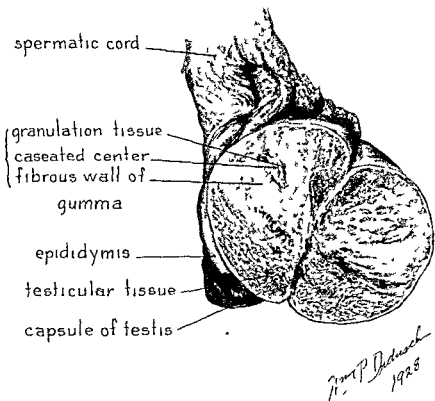


FIG 83 Testicular gumma in a 27 year-old patient (Specimen from Museum of Dr E Christeller, Virchow's Krankenhaus, Berlin)

The acute interstitial form may manifest itself as early as the second month of the disease, or as late as the fifth year. The swelling is usually moderate and most noticeable in the globus major, though the whole epididymis may be involved. Hydrocele is a frequent accompaniment.

Chronic syphilitic epididymitis rarely occurs before the third year of the disease, and may follow an acute infection, or develop slowly and painlessly. The swelling primarily affects the globus major and is

diffuse Later the entire epididymis is involved and presents a board like rigidity

Epididymal gummas are late manifestations and are usually unilateral They manifest themselves as one or more hard nodular masses in the epididymis and like tuberculosis may break down and form scrotal fistulas

Orchitis and epididymitis are sometimes observed simultaneously in the tertiary stage of syphilis although it is the testicle which is usually the first affected the process later extending to the adjacent organ In the sclerotic form extension is less likely to take place A gummatous process usually involves the adjacent tissues first by extension of the inflammation and later by ulceration Sometimes it will be impossible to tell whether such a gumma arose in the testicle or epididymis as the entire structure will have been changed into an unrecognizable gummatous mass while a hydrocele will have formed in the greatly thickened tunica vaginalis

**Symptoms and Diagnosis** The most frequent complaint in syphilitic orchitis is of diminution or loss of sexual power The disease usually occurs in middle or later life It is occasionally bilateral The onset is insidious The testicle is moderately enlarged rounded smooth and insensitive to palpation There is no fever The Wassermann and Kahn tests will be positive

Acute syphilitic epididymitis is sudden in onset Pain which is increased on motion is always in evidence and may be very severe The swelling however is usually not great and the surface of the epididymis is smooth and elastic so that it can readily be differentiated from the testicle on palpation Chronic syphilitic epididymitis commonly follows an acute condition but occasionally may develop so slowly and painlessly that the patient is unaware of anything abnormal until his attention is attracted to the swelling in the scrotum Sometimes however the swelling is accompanied by a dull dragging ache in the inguinal region and within the scrotum for the relief of which medical advice is sought The epididymis will be found indurated particularly in the region of the globus major and if seen early enough elastic Later there will be rigidity of the entire organ

Gonorrhea tuberculosis non specific infections and tumors all of which frequently affect the testicle and epididymis must be ruled out

Gonorrhea presents few difficulties as it is easily identified bacteriologically Moreover a gonorrheal process is much more acute and there is usually a concurrent urethritis to give confirmative evidence

Tuberculosis offers considerably more difficulty Syphilis usually makes its initial appearance in the testicle, while tuberculosis is first clinically evident in the epididymis Other important points are the history, the negative rectal findings in syphilis, and the preference of syphilis (in the early stages) for the globus major in contradistinction to that of tuberculosis for the globus minor

In a malignant process the patient is frequently cachectic and the regional lymph nodes are usually involved Progression in malignancy (sarcoma especially) is more rapid than in syphilis and the later stages, at least, give rise to pain, which is usually absent in syphilis A malignant process is less diffuse than a syphilitic one, usually remaining sharply localized until far advanced The hormonal test facilitates the differentiation

The final test ordinarily rests upon the result of carefully taken Wassermann and Kahn tests on both blood and spinal fluid and the response to antisyphilitic treatment Under the latter the active lesions disappear with remarkable rapidity, although full restoration of the affected organ is seldom possible

**Prognosis** The outlook of a patient suffering from syphilitic epididymo-orchitis is not an unhappy one unless the disease has progressed to the stage where there is extensive destruction of tissue If this has occurred, however, there is little likelihood that the patient will regain his sexual power

**Treatment** The treatment is the same as for syphilis elsewhere in the human body, and consists of intravenous injections of neoarsphenamine, bismuth, and mercury, as well as mercurial inunctions

### *Neuralgia of the Testicle and Epididymis*

Neuralgia of the testicle and epididymis is a relatively uncommon condition characterized solely by pain in the gland or its excretory canal The pain may be due to local causes or be transmitted, and is as a rule, of considerable intensity and paroxysmal As early as 1830, Sir Astley Cooper described the condition under the heading "the irritable testis" and believed it to be a nervous disorder akin to *tic douloureux*

**Etiology** Three types of neuralgia have been differentiated by Monod and Terillon

(1) Neuralgia without apparent local alteration in the testicle There is an extremely sensitive localized area, the sensibility sometimes lasting for months or even years despite all forms of treatment It is sometimes seen in children as a hysterical manifestation or is the result of spasmodic

retraction of the testicle, or may occur temporarily following prolonged sexual excitement without detumescence

(2) Symptomatic neuralgia dependent upon an active or healed lesion of the testicle or epididymis Atrophic and previously diseased testicles are sometimes subject to neuralgic pains which occasionally may be so intense as to necessitate orchidectomy

(3) Symptomatic neuralgia reflexly affecting the testicle from lesions of other organs Among the lesions that may cause referred pains in the testicle are renal or ureteral calculus, prostatitis and seminal vesiculitis, diseases of the bladder, and hernia Scrotal conditions, such as hydrocele, adhesions of the tunica vaginalis, occlusion of the epididymis or vas, and extratesticular tumors and cysts, are all possible factors in neuralgia Sexual neuroses, with or without disease of the genitalia, are often responsible

**Diagnosis** A careful history and examination of the testicle, epididymis, and vas deferens will generally reveal the causative factors Inquiry should be made particularly regarding trauma and gonorrheal or other inflammatory conditions of the testicle and epididymis Should examination reveal no cause, either locally or outside the gland, for the neuralgia, a neurotic or psychoneurotic basis for the condition should be considered

**Prognosis** The prognosis is good Cure of the neuralgia depends upon elimination of the cause, which can usually be accomplished once this has been ascertained

**Treatment** If palliative measures are unsuccessful in relieving the pain, denervation of the testicle and epididymis may be necessary Orchidectomy has occasionally been done, but should rarely be required

### *Thrombo Anguitis Obliterans of the Spermatic Vessels*

An exceedingly rare lesion, yet worthy of record because of the importance of prompt recognition when it does occur, is thrombo-anguitis of the spermatic vessels, ultimately leading to gangrene of the involved testicle Buerger, to whom we are indebted for knowledge concerning the disease (commonly called "Buerger's disease"), reported some 400 cases of involvement of the lower extremities and, in a few instances, of the upper extremities, but mentioned only one case of thrombosis of the spermatic vessels

McGregor and Simson, in 1929, reported an interesting case Their patient, like practically all of Buerger's, was a Jew His complaint was of a dull, nagging pain over the penis, left half of the scrotum, and

lower abdominal wall. The left testicle had previously been swollen and painful. Examination showed two nodules in the epididymis and slight thickening of the cord. As the cutaneous tuberculin test was positive, a diagnosis of tuberculosis was made and operation advised. On dissection, the vas deferens was found to be normal, the apparent thickening of its upper part, detected clinically, being due to the firm adhesion of many blood vessels to the periphery of the vas, giving the impression, on palpation, of thickening of the duct. The spermatic vessels showed all the pathological changes enumerated by Buerger as characterizing thrombo anguitis obliterans: infiltration of the coats of the vessels and surrounding tissue by inflammatory cells, occlusive thrombosis of the affected part of the vessel, the formation of purulent foci in the clot, replacement of the leukocyte areas by altered angioblasts and giant cells, organization of the bland portion of the clot, and canalization of the organized tissue.

### *Tumors of the Testicle*

**Introduction** Tumors of the testicle have been recognized since early in medical history and have always been of great interest to surgeons. For many years, all hard fleshy tumors (including, no doubt, tuberculous and syphilitic as well as neoplastic lesions) were grouped together under the term "sarcocoele." In 1696, Donat described a testicular tumor containing fetal structures and bones. The latter half of the nineteenth century saw considerable progress in the clinical and microscopic differentiation of the various types of testicular tumors. Curling (1853) divided tumors of the testicle into two groups: (1) benign cystic and (2) solid malignant. In 1854, Johnson identified derivatives of all three primary germinal tissues in a testicular tumor, and in 1887 Kocher and Langhans established the tridermal origin of a large proportion of these tumors. In 1906, Chevassu differentiated a highly malignant tumor which he believed arose from spermatoblasts and for which he suggested the name *seminoma*.

Despite the relative infrequency of tumors of the testicle, there is a voluminous literature on the subject, due, no doubt, to the wide divergence of opinion regarding their origin, classification, and treatment. The discovery by Zondek (1929) of prolactin A (the follicle stimulating hormone of the anterior pituitary body) in the urine of a patient suffering from teratoma testis has materially changed our concept of these tumors, and has helped to place their diagnosis, prognosis, and treatment on a more exact and scientific basis. Through a quantitative estimation

of the hormone excreted in the urine, not only the presence of the tumor but its type, degree of malignancy, and, to a certain extent its radio-sensitivity, may be determined before the institution of treatment, and the results of treatment followed. Unfortunately, all testicular tumors do not throw off the gonadotropic hormone, so that while a positive reaction to the hormonal test is of the greatest diagnostic assistance, a negative reaction must be disregarded.

**Incidence of Testicular Tumors** Tumors of the testicle are uncommon, but occur with sufficient frequency to be of great interest to the general practitioner, as well as to the urologist. The great majority of testicular tumors are malignant. Benign tumors are very rare, and consist chiefly of solid and cystic adenomas, dermoid cysts, and benign embryomas. It is extremely difficult to obtain any reliable estimates of the incidence of testicular tumors. A. L. Dean, of the Memorial Hospital, in New York, places malignant tumors of the testicle at 3.39 per cent of all tumors of the genito-urinary tract, and at 2.09 per cent of all malignant tumors in the male.

The disease is one of early adult life, the greatest age incidence being between the ages of 20 and 40 years, but all ages may be affected—infants as well as the aged. There have been numerous reports of malignant tumors, usually teratomas, in the newborn.

Most authors report the right side as being involved more often than the left. Bilateral involvement is rare, and occurs in undescended testicles 20 times more frequently than in normally descended glands.

**Etiology** The etiology of testicular tumors is obscure. Heredity seems to play little, if any, part. Sexual activity may be a factor, since the majority of cases occur during the period of greatest vigor.

The prevalent impression that the undescended testicle is more likely to develop a tumor than the normally situated organ appears to be borne out by the more recently gathered statistics on the subject. Dean (1929) found tumor in undescended testicles 225 times as often as in the normally descended organ. The inguinally retained gland is liable to suffer repeated small injuries from the constant contractions and movements of the muscles forming the inguinal region, and the abdominal testis is exposed to varying changes in intra-abdominal pressure and is likely to be compressed when any sudden effort is made. The importance of these factors in relation to an organ already the seat of disturbed function and embryological defects can, of course, be only a matter of conjecture, but the relatively high incidence of tumor in the imperfectly descended

organ indicates that cryptorchidism is a predisposing factor of sufficient importance to warrant careful consideration  $\frac{1}{2} + \frac{1}{4} = \frac{3}{4}$

The only real evidence that trauma may be of etiological importance is the fact that the undescended testicle, with its greater exposure to trauma, is more prone to become cancerous than the normally situated organ

Other possible etiological factors that have been suggested are disturbances in important hormonal interrelationships, interference with the intercellular circulation, and changes in functional activity due to advancing age and certain biochemical phenomena

**Pathology.** Practically all pathologists and clinicians agree that all testicular neoplasms are malignant or potentially so. Much has been written in recent years concerning the nature and origin of testicular neoplasms. Interpretations of pathogenesis differ widely, and there is little unanimity regarding the proper classification and nomenclature of these tumors

Tumors may arise from any type of cell present in the testicular tissues. Various degrees of differentiation are found, with corresponding variation in the clinical course, degree of malignancy, radiosensitivity, and prognosis. Some tumors resemble closely the cells of the seminiferous tubules. These are called *embryonal tumors*, and are believed to be derived from primordial and primitive sex cells. They are malignant from the start, and are most frequent between the ages of 20 and 40 years. Most tumors of the testicle are of this type. The proved embryonal tumors should be further subdivided into the apparently unicellular and the teratomatous (mixed cell) types. Ewing believes that all tumors of the testicle are of teratomatous origin, the unicellular seminoma being merely a one-sided development of a heterogeneous growth to the exclusion of the other elements.

A second group consists of tumors containing a mixture of adult tissues similar to those found in the mediastinum and elsewhere. These tumors, which are called *adult teratomas*, are believed to be derived from isolated blastomeres. They appear to have no relation to the embryonal group. A gonadotropic hormone is not excreted in the urine of patients with adult teratomas and none of this substance can be extracted from these tumors. Adult teratomas are essentially benign but potentially malignant. They may occur at any age, but when malignancy takes place it usually does so during the so-called 'cancer age'—that is, after the fortieth year. These tumors metastasize rarely and late and may be

successfully removed before local extension or distant metastasis occurs. They are radioresistant. Unfortunately, they comprise less than 10 per cent of teratomas.

A third, or *miscellaneous group* of tumors, which are extremely rare, are derived from adult somatic cells within the testicle, such as lymphocytic cells, interstitial cells, muscle cells, suprarenal rests, and other elements.

The main forms of testicular neoplasms which can be recognized are (1) the adult teratomas (rare), (2) embryonal carcinoma with lymphoid

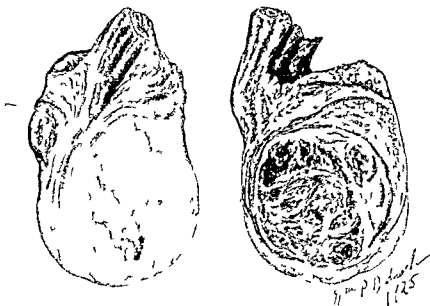


FIG. 84 Teratoma testis. The external view shows the nodular nature of the growth, the transverse section its teratomatous character.

stroma, (3) embryonal adenocarcinoma, (4) chorionepithelioma. All of these can be considered as teratomas in different stages of development.

Embryonal carcinomas with lymphoid stroma (seminomas) make up the majority of malignant tumors of the testis. They are highly malignant, and show a considerable variation in their natural history, hormone output, and radiosensitivity. They occur chiefly in young men (20 to 30 years), and have a tendency to metastasize early and widely.

*Chorionepithelioma* is a very rare, highly malignant form of teratoma, similar in its course and structure to the chorionic carcinoma of the uterus. Its origin is still obscure. There is seldom gross enlargement



in the testicle, but the tumor metastasizes early and extensively. No other tumor shows such a high excretion of hormone in the urine (100,000 or more mouse units per liter of urine).

Kirwin, reporting a case of chorionepithelioma of the testicle in 1937, carefully reviewed the literature and summarized the data accumulated to date. He found that as far back as 1878 Malassez and Monod described a malignant chorionepithelioma of the testicle, but supposed it to be a sarcoma. In 1902 Wlassow, reporting four cases of testicular

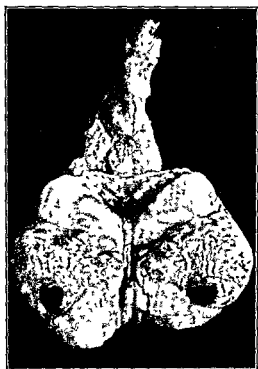


FIG 85 Teratoma of the testicle. Showing the mixed tissue in the gross specimen. Above the black nodule in the lower portion is yellow fibrous tissue, in the inner border of which are nodules of another type.

tumor, mentioned the striking resemblance which he had noted in two of them to the chorionepitheliomas seen in the uterus, and observed that in all his tumors the greater proportion of the cells were of what we now know as the Langhans type (polygonal cells, clear and glycogenic in character, and having an arrangement suggesting alveolar sarcoma or medullary carcinoma). Wlassow proposed the name *epithelioma syncyomatodes testiculi* for this peculiar type of neoplastic growth, because its larger cells were apparently derived from a source analogous to the

syncytium, while the smaller ones partook of the nature of those composing the chorionic villi

In 1902, Schlagenhauser correlated the pathological and histological data which had accumulated up to that time, and suggested the name *malignant chorionepithelioma of the testicle*, which he based upon his conclusion that the growth in question is genetically equivalent to the chorionepithelioma seen in the female and is originated in a teratoma. Although much more has been learned about testicular teratomas in recent years, and Schlagenhauser's assumptions have been many times assailed, they have not been disproved. Later writers who have contributed important observations to the subject of chorionepithelioma of the testicle are Steinert (1902), Risel (1903), Warthin (1909), J. V. Cooke (1915), Jeanneret (1928), Ferguson (1933), Fortner and Owen (1935), and Callens (1935). Ross collected 131 cases of proved chorionepithelioma of the testicle in 1932, to which she added one more. The more recent reports emphasize the enlargement of the breasts which is a late manifestation in these cases and which gives strong confirmatory support to the unsettled question of the relation of these tumors to the chorionepitheliomas of the uterus long familiar to pathologists.

Kirwin's patient, a 34 year-old man, already had metastases when he applied for treatment of a mass in the right side of the scrotum. Examination revealed a teratoid growth. Orchidectomy was done, and, the pathologist's report showing malignancy, deep x ray was applied to the site of the growth. The patient died a few months later. Autopsy showed metastatic growths in the lungs, liver, brain, kidneys, and other organs (Frontispiece). The primary testicular tumor consisted in large part of adult teratoma with formation of cartilage and spaces lined by columnar or stratified squamous epithelium. In other areas were masses of pale cells suggesting the Langhans layer of the chorionic villus, and also syncytial masses with darker cytoplasm and many nuclei suggesting the syncytial layer of a chorionic villus. The metastatic nodules of the viscera contained the Langhans type of cell and syncytial cells in varying proportions.

**Symptoms, Signs, and Diagnosis of Testicular Tumor** Testicular tumors affect all ages, from infants to men over 70 years of age, but about 80 per cent occur between the ages of 20 and 40 years.

The initial symptom is almost always a painless swelling of the testicle accompanied by a sense of weight in the scrotum. Usually the patient's

attention is attracted to the enlargement by some trauma, often insignificant. Patients sometimes give a history of having noticed a gradual enlargement, to which they paid no attention because of the absence of pain. Any painless swelling of a testicle in a young man should arouse the suspicion of a malignant tumor. Frequently the small primary focus in the testis goes entirely unnoticed by the patient, and the first symptoms of the disease may be due to lymphatic involvement or metastases to distant structures. Such symptoms include loss of weight, an abdominal mass, slight cough, pain in the abdomen, back, or scrotum. Pressure of the enlarged para aortic nodes on the veins may cause edema of the lower extremities or scrotum. Pressure of the enlarged nodes may also produce gastrointestinal symptoms or cause compression of the ureter, with symptoms of occlusion.

The insidious onset, with periods of latency, renders uncertain the estimation of duration. Most testicular tumors grow rapidly and have been present less than a year when the patient is first seen by the physician. More slowly growing tumors such as adult types of teratoma and an occasional seminoma, may have existed as long as 3 to 4 years before inducing their bearers to seek medical advice. Metastasis usually occurs early and extends first to the abdominal retroperitoneal lymph nodes. The disease early enters the blood stream and becomes widely disseminated.

Palpation usually reveals the tumor as preserving the shape of the testicle. In the earlier stages the surface of the tumor is generally smooth and regular. Nodules and irregularities and softening and fluctuation over areas of cystic degeneration occur in the later stages. In the earlier stages the epididymis may be felt as a nodular cord, but later it becomes lost in the enlargement. The surface blood vessels on the affected side are often dilated and tortuous. The scrotal skin may appear red and shiny from being stretched, but is generally freely movable over the mass. Involvement of the scrotum and ulceration through it are very late manifestations. The inguinal nodes may be palpable, but their involvement occurs only in advanced cases after the scrotal tissues have been invaded. The spermatic cord may be thickened from the weight of the tumor and the increased blood supply, but it is rarely invaded until very late. Local tenderness is absent or relatively slight except in advanced cases. Hydrocele is a frequent accompaniment.

Testicular tumors vary markedly in size, some being little larger than

the normal testicle while others reach the size of a small melon. The increase in size may be progressive or there may be periods of latency. A chorionepithelioma may be so small as to be overlooked in life.

Examination for metastases should always include an x ray of the lungs.

*Metastases* Metastasis may take place by way of the blood stream or the lymphatics, most frequently the latter. The inguinal nodes are involved only when the scrotal tissues have been invaded. Metastatic involvement of the primary lymph zone is, unfortunately, impossible to detect clinically until large nodes have developed, due to the deep abdominal position of the lymph nodes. By this time, generalized metastases are likely to have set in.

Most teratomas are highly malignant, grow rapidly, and metastasize early. A tumor of considerable size will develop in the course of a few months and will invade the lymphatics and blood stream, distributing the disease to the lumbar, mediastinal, epigastric and supraclavicular lymph nodes and through the blood to the lungs. Chorionepitheliomas metastasize widely and with great rapidity.

*Differential Diagnosis* Malignancy of the testicle is very difficult to recognize in its early stages. Clinical recognition is largely a matter of exclusion, as the tumors present no pathognomonic signs or symptoms. Even after enlargement is plainly visible there may be a long period when pain and tenderness are entirely absent and even when these are present in conjunction with enlargement of the gland, this combination is of little diagnostic value since these symptoms are common to several other testicular conditions. All testicular swellings must therefore be regarded as malignant until proved benign. Hydrocele and hematocele, syphilis, and tuberculosis present clinical difficulties in differentiation.

*Hydrocele or hematocele* may completely mask an underlying tumor. Patients frequently give a history of repeated tapplings of the accompanying hydrocele before the true condition was even suspected. Hydrocele and hematocele sometimes show indurated areas due to absorption and organization, that may present problems in differentiation. The large, soft embryonal tumors resemble hydrocele but the latter may usually be differentiated by transillumination. Palpation is of assistance in ruling out hematocele. If, for instance the tunica vaginalis can be palpated upon the surface of a scrotal tumor, that tumor is not a hematocele. Also as the epididymis is invariably embedded within a hematocele it will be impossible to palpate it if a hematocele is present, therefore,

ability to palpate the epididymis indicates that the tumor is not a hematocele

Exploratory puncture, a procedure fraught with danger should the tumor be malignant, is to be avoided

Gumma more nearly and more often simulates tumor than any other testicular lesion, and one should remember that generalized syphilis and testicular malignancy may coexist. A positive Wassermann or response to antiluetic therapy should not be cause for too long delay. It is preferable to remove a gumma (as has frequently been done) than to delay in the removal of a malignant tumor. In both syphilis and malignancy the testicle is primarily implicated, but progression in syphilis is generally slower than in malignancy. The hormonal test is of value in these cases

In tuberculosis, the epididymis is the seat of primary infection, and, as a rule, it is only in the very late stages, when the testicle is involved by extension and there is a massive epididymo orchitis, that there is likelihood of differential difficulties between tuberculosis and malignancy. In tuberculosis, evidences of the disease elsewhere in the body are usually present, the epididymis and frequently the vas deferens are nodular and rectal palpation will reveal involvement of the prostate and seminal vesicles. Tuberculous lesions commonly ulcerate and form a scrotal sinus

*The Hormonal Test* In recent years, the application of the Aschheim Zondek reaction has proved of great value in the diagnosis and differential diagnosis of testicular tumors

Early in the employment of the Aschheim Zondek test for pregnancy was found that chorionepithelioma of the uterus is associated with exaggerated production and elimination of the anterior hypophyseal hormone, the amount lying somewhere between the physiological level (5 mouse units to the liter of urine) and the greatly increased level of pregnancy

In 1929, Zondek first observed the appearance of a gonadotropic hormone in the urine of a man suffering from teratoma testis, and three years later reported his observations on the use of this test in the diagnosis of teratoma in 14 cases. Heidrich and Fels, in 1930, reported the excretion of these hormones in a case of chorionepithelioma of the testis, which they demonstrated to be morphologically identical with that occurring in the uterus. In 1931, Ferguson observed that irradiation of the tumor caused the disappearance of the hormone from the urine, and in 1933 he pub-

lished a technic for determining the quantity of hormone in a given specimen of urine and also demonstrated that the amount of prolan A excreted in the urine depends upon the type of tumor present in the testicle. By calculating the number of mouse units present per liter of urine, it was ascertained that in cases of teratoma with adult features, or in embryonal carcinoma, the prolan excretion is low, but if the neoplasm is an embryonal adenocarcinoma or a chorionepithelioma, the excretion may reach as high as from 10 000 to 100,000 or more mouse units per liter.

A positive Aschheim Zondek test is of the greatest diagnostic assistance, but a negative reaction must be disregarded since certain tumors do not give off this hormone. The relative radiosensitivity or non-sensitivity of the tumor is indicated to a certain degree by the rapidity and degree of disappearance of the hormone from the urine after irradiation of the primary growth prior to orchidectomy. If there is no material decrease, the prognosis is poor, if the hormone rapidly disappears after irradiation it is more favorable.

Every case suspected of being a malignant tumor of the testicle should have a quantitative estimation of the gonadotropic hormone in the urine, unless diagnosis can positively be made without it. Recently it has been demonstrated that very small amounts (less than 50 mouse units per liter of urine) may be present in cryptorchids castrates and those in whom the testicle is atrophied. The hormone is not present in benign tumors or other testicular lesions. Therefore, amounts over 50 mouse units per liter indicate that a malignant process is present.

The studies of various investigators indicate that chorionepithelioma will cause the excretion of prolan A in the urine in excess of 50 000 mouse units per liter; embryonal adenocarcinoma from 10 000 to 40 000 mouse units per liter; embryonal carcinoma with lymphoid stroma 400 to 10 000 mouse units; and teratoma with adult features 50 to 500 mouse units per liter. The amount of hormone increases in proportion to the embryonal character of the neoplasm. Quantitative estimation of the hormone therefore, not only definitely indicates the presence of neoplasm but also its structural type and degree of malignancy. It also shows the extent of the malignant process, the amount of prolan being increased by widespread metastatic dissemination. An increase of the hormone in the patient's urine has been observed from 1 to 3 months before metastatic lesions or local recurrence could be detected clinically.

In addition to its diagnostic value the quantitative hormonal test is

of importance in judging the efficiency of treatment and in the early detection of recurrence and metastases

**Prognosis** The prognosis depends on the extent and rapidity of growth of the metastases, on the type of tumor and its radiosensitivity, and on the general physical condition of the patient

The primitive type of embryonal tumor, whether mixed or unicellular, is rarely cured by irradiation. Possibly, if the testicular tumor is detected early enough and removed surgically before handling has permitted cells to be squeezed into the lymphatic channels, a cure of the most primitive type of tumor might be effected, but such tumors are of rapid growth and metastasize widely and early

Pure embryonal adenocarcinomas behave similarly to the primitive tumors, but the more differentiated mixed tumors, in which adenocarcinoma may also be present, are slower growing and give better opportunity for treatment. The prognosis though better than that in the primitive types of tumor, is nevertheless poor. As a rule, the tumors of this group are radioresistant

Teratomas containing cartilage, areas resembling bowel, adenocarcinoma, etc., most frequently offer the ideal opportunity for the combined use of surgery and radiation—that is, careful surgical removal of the primary tumor, with subsequent radical removal of the abdominal lymph nodes and massive doses of radiation

The differentiated types of embryonal carcinoma are radiosensitive and most urologists believe that radiation offers the best opportunity for cure

Any prognosis is tentative, but the histological structure of the tumor, together with the complete hormonal data, permits a fairly accurate forecast of the probable course of a testicular neoplasm. The rapidity and extent of decrease of prolan A in the urine following irradiation are good indices of the tumor's radiosensitivity, and to a certain extent may therefore be regarded as reliable factors on which to base a prognosis

**Treatment** There are four principal methods of treatment: (1) simple orchidectomy, (2) orchidectomy and irradiation, (3) radical operation including removal of the regional and retroperitoneal lymph nodes on the side corresponding to the affected testicle, followed by deep x-ray irradiation, (4) irradiation alone. Orchidectomy alone is never curative when metastases have occurred, and is indicated mainly for diagnosis. The greatest care must be exercised in handling the testicle, to avoid disseminating malignant cells along the spermatic cord. The

surgeon's subsequent course depends upon the findings of microscopic examination of the tumor, correlated with the findings of clinical examination and the biological tests. In other words, it depends on the type of tumor that is present, on whether or not metastases are demonstrable, and on the relative radiosensitivity or radioresistance of the tumor. When tumor cells have passed beyond the primary field (the testicle with its primary lymphatic system), operation is useless.

When there are no demonstrable metastases and the patient's general health is good, the radical operation—i.e., orchidectomy and removal of the retroperitoneal lymph nodes—followed by a thorough course of deep x ray therapy, is, we believe, the treatment of choice (*Radical Operation for Extirpation of Tumor of the Testicle*, p. 498). In other cases, orchidectomy followed by deep x ray therapy directed to the primary and abdominal regions, is indicated (*Radium and Roentgen Ray Therapy of the Genito-Urinary Tract*, p. 1736).

### *Hodgkin's Disease of the Testicle*

Among the rare tumors of the testicle is that caused by lymphadenoma or Hodgkin's disease. A generalized lymphadenoma may be manifested, during its terminal stage, in the testicle or elsewhere upon the genitals without attracting special attention (*Hodgkin's Disease of the Penis*, p. 304). A few cases have been reported in which the disease first manifested itself in the scrotal contents. Ziegler, in his general discussion of Hodgkin's disease (1911), has provided a good clinical description of this affection as it appears in the testicle. Detailed reports on individual cases have been published more recently by Sicard and Pavil (1930), Townsend (1935), and Findlay (1937).

**Etiology.** The origin of Hodgkin's disease, like that of most malignant affections, is obscure. Many investigators have related it to invasion by the tubercle bacillus, but this has never been positively established. It is interesting, in consideration of its manifestation in the male genital gland, to recall the fact that men are far more subject to lymphadenoma than are women, the ratio being something like 15 to 1. *Tuberculosis of the genital tract is likewise more prevalent in the male sex.*

**Diagnosis.** The diagnosis can be positively established only by microscopic examination especially in the absence of any manifestations of the disease in other parts of the body.

**Prognosis.** Hodgkin's disease of the testicle is regularly bilateral



and, so far as the literature can enlighten us, the prognosis is absolutely hopeless. The possibility of its occurrence should be kept in mind, however, in the differential diagnosis of testicular tumors.

### *Tumors of the Testicular Tunics, Epididymis, and Spermatic Cord*

Tumors within the scrotum, which do not originate in the testicle proper, are uncommon. Cystic conditions such as hydrocele and spermatocele of the cord and epididymis, are discussed elsewhere, but in addition to these there occasionally occur true neoplasms of the scrotal contents, which have their origin in the cord, the epididymis, or in the testicular tunics. The vast majority of extratesticular tumors involve the spermatic cord.

#### TUMORS OF THE SPERMATIC CORD

Solid tumors of the spermatic cord are rare. Patel and Chalker (1909), in a very complete review of the literature, found but 89 cases: lipoma, 37, sarcoma and fibrosarcoma 22, mixed tumors, 13, fibroma 12, myoma, 4, carcinoma, 1. No inciting or predisposing cause is known. They arise from the various elements of the cord.

**Benign Tumors of the Cord.** *Lipoma* of the cord has been quite frequently reported. Such fatty tumors are usually of slow growth and sometimes attain enormous size. As a rule, the growth develops from the subserous fat around the internal inguinal ring. As it enlarges, it grows along the inguinal canal, distending it and acting as a predisposing cause of hernia. The growth may extend upward and come to a sudden halt in the inguinal canal, or it may become fused with the properitoneal fat and finally reach the testicle and epididymis, or even break through the tunica vaginalis and form connection with the subcutaneous fat, in which event its true origin may be impossible to recognize. True lipomas of the cord must be distinguished from the more common lipomas arising from the properitoneal fat. G. J. Thompson, who reviewed the subject in 1936, has pointed out that a lipoma of the spermatic cord should always be surrounded by the tunica vaginalis and derive its main blood supply from the vessels of the cord, but in time the true lipoma of the cord may break through the tunica vaginalis and will connect so closely with the properitoneal fat that it appears to have its origin there.

*Fibroma* of the cord occurs much less frequently than lipoma, and usually appears to originate in the caudad portion of the cord near its

junction with the epididymis, at a point where the various elements of the cord are united by connective tissue. These growths are slow-growing and painless, and are frequently mistaken for hernia, cyst, or hydrocele. They may sometimes be reduced into the abdomen, may give an impulse on coughing, or even transmit light. Not uncommonly they become sarcomatous.

Other benign tumors of the cord that have occasionally been reported are *myoma* and *myxofibroma*, *leiomyoma*, and *lymphangioma*. Simple *dermoid cysts* are more common, and usually appear in the inguinal region.

**Malignant Tumors of the Cord** The most common malignant tumor of the spermatic cord is *sarcoma* or some combination of sarcomatous and other tissue, such as *myxosarcoma*, *liposarcoma*, *chondrosarcoma*, *fibrosarcoma*, or *rhabdomyosarcoma*. Sarcomatous tumors are practically always found in the scrotum, very rarely in the inguinal canal. In some instances, at least, they appear to arise in fibromas.

The single case of *carcinoma* mentioned in Patel and Chalker's list—that of Tedenat, reported in 1908—appears to be the only one on record.

**Diagnosis of Tumors of the Cord** The differentiation of tumors of the cord from other conditions in this region requires very careful consideration. More often than not, such tumors are diagnosed as hydrocele of the cord, cyst, hernia, spermatocele, or gumma. With the exception of lipomas and dermoid cysts, which are usually situated in the inguinal canal, most tumors of the cord occur lower down, in the scrotum. In general, the same rules apply to the diagnosis of tumors of the cord as for testicular growths. In view of the comparatively high proportion of malignant tumors of the cord, early diagnosis is of the utmost importance. When all other diagnostic facilities have been employed, and there is still doubt regarding the true nature of a tumor, exploratory operation is indicated.

**Treatment of Tumors of the Cord** Simple enucleation usually suffices for benign tumors. The clinical course of *sarcoma of the cord* and the results of treatment are very similar to those reported from the handling of *teratoma of the testicle*. These tumors should therefore, receive the same radical treatment accorded testicular tumors. The lymphatics of the cord, epididymis, and testicular tunics like those of the testicle drain directly into the retroperitoneal lumbar lymph nodes along the aorta and vena cava. Only when there is involvement of the skin—a very rare complication—is there secondary involvement of the inguinal nodes.

## TUMORS OF THE EPIDIDYMIS

Primary solid tumors of the epididymis are extremely rare and our knowledge regarding them meager. Myoma and angioma are the most common benign tumors. Of 36 malignant tumors of the epididymis collected by Thompson in 1936, 23 were of epithelial origin, 12 of the sarcoma type, and 1 a teratoma. Teratoid tumors, originating in the rete testis, may in their early stages invade mainly the head of the epididymis and clinically give the appearance of a primary tumor of the epididymis. Such tumors give a positive Aschheim Zondek reaction.

**Diagnosis.** Tumors of the epididymis are predominantly malignant, and early diagnosis is therefore of the greatest importance. Errors of diagnosis are prone to occur, because of the rarity of malignant growths of the epididymis and their close clinical resemblance to chronic inflammatory conditions. "When in doubt, operate" is therefore the only safe attitude to assume when tumor is suspected. Differential diagnosis would not present such difficulties if the possibility of tumor were always borne in mind. Mistaken diagnoses are not usually made because of defective history taking or incomplete physical examination, but simply because the physician fails to keep in mind all the possibilities.

Epididymectomy will definitely establish the diagnosis, and it is far better to remove a gummatous or chronically inflamed epididymis, erroneously suspected of being malignant, than to overlook a malignant process.

Clinical differentiation between involvement of the testicle and the epididymis may be quite impossible, but the diagnostic points detailed in the section on the testicle apply also to the epididymis.

**Treatment.** The epididymectomy done for diagnostic purposes may suffice. The teratoid tumors should receive the same treatment as teratomas of the testicle and early radical operation should be done when indicated.

## TUMORS OF THE TESTICULAR TUNICS

Tumors of the vaginal and albugineal tunics and fascial sheaths appear to be very rare but as it is usually impossible to differentiate clinically, and sometimes even pathologically, neoplasms of these structures from those arising from the epididymis and cord, a true estimate of their frequency is difficult to obtain. The tunica vaginalis is far more often the site of tumor than the tunica albuginea. *Fibromas* are the most common. Valdoni collecting 18 cases in 1927. *Myoma*, *leiomyoma*, and *chondroma* have been reported. Valdoni also collected 26 cases of

sarcoma of the tunica vaginalis Thompson (1936) found 56 cases—35 benign and 17 malignant Only 4 of these were of the tunica vaginalis

**Diagnosis and Treatment** The fact that most of these tumors, like those of the adjacent structures, are malignant makes early diagnosis and treatment imperative Since clinical differentiation is almost invariably impossible, surgical exploration is usually indicated The subsequent course depends upon the operative and microscopic findings, but follows along the lines of treatment of testicular and epididymal tumors

### *Hydrocele*

Hydrocele is an accumulation of fluid within a serous sac, especially the tunica vaginalis testis or the vaginal process of the spermatic cord It may occur at any age, and may be *symptomatic* or *idiopathic*, *acute* or *chronic*

**Etiology** *Acute* hydrocele is usually *symptomatic*, and may be secondary to trauma or inflammation of the testicle and epididymis, or it may occur as a complication of some systemic disease, such as typhoid fever or syphilis In fevers, the formation of a hydrocele resembles the effusion into the joints or the pleura, and is the result of a blood infection or of chemical irritation A hydrocele formed in the course of a general disease should be tapped at once and a microscopic search made for the specific organism Hydrocele is often a sequel to gonorrhea, but may also be due to infections with other organisms such as the colon bacillus or the pneumococcus

*Chronic* hydrocele may follow the acute form, but in the majority of cases no cause can be found It is frequently bilateral

*Congenital* hydrocele occurs before closure of the funicular process, so that the sac communicates with the peritoneal cavity The opening is usually so minute that hernia cannot take place and the fluid is retained in the sac instead of flowing out into the abdomen This form usually disappears spontaneously in infancy Hydrocele may also occur when the funicular process is closed at its superior outlet, the fluid thus distending both the tunica vaginalis and the funicular process This is termed *infantile* hydrocele There is no communication with the abdominal cavity

The so-called *idiopathic* hydrocele is by far the most common type Campbell, reviewing 502 cases in 1927, could find no etiological factor in 311 cases An antecedent asymptomatic inflammation or trauma is undoubtedly the underlying cause in many of these cases

It is probable that in children and adolescents some abnormality of the spermatic cord or testicle is frequently a causative factor, and that in the middle-aged and elderly the vascular changes accompanying the decline of virility contribute to its incidence

**Types of Hydrocele** *Hydrocele of the tunica vaginalis testis* (Fig 86), is the most common form This may be congenital or infantile, but is

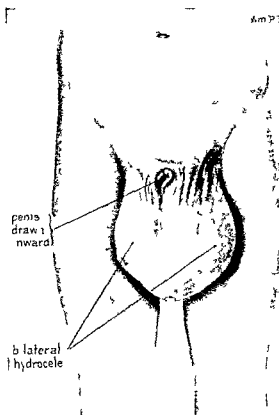


FIG 86 Bilateral hydrocele of the tunica vaginalis

usually secondary to trauma inflammation, or systemic disease, or of unknown etiology An *inguinal hydrocele* is one accompanying an undescended testicle *Encysted* hydrocele of the testis and epididymis may occur between the tunica albuginea of the testicle and the visceral layer of the tunica vaginalis, or it may arise at the point where the two layers of the tunica vaginalis continue from the testicle onto the epididymis

*Hydrocele of the spermatic cord* may be a diffuse serous effusion into the cord or it may be encysted. The latter may be either single or multiple.

*Hydrocele of a hernial sac* is an effusion of fluid into the sac of a hernia, the orifice of which has become blocked by adhesions or an omental plug.

*Interstitial hydrocele* is a rare form in which the sac consists of two chambers, one of which is within the scrotum and the other directed up toward the abdomen. In the inguinal canal will be found the 'neck' which separates the two chambers. Such a hydrocele is nearly always right sided and will have associated with it some degree of ectopia of the testicle. It is possible that this type occurs only in conjunction with maldevelopment of the testicle, when there is invariably some abnormality of the tunica vaginalis. Originally arising in the upper part of the scrotum above the testicle, the fluid gradually distends the vaginal tunic forcing the sac up into the inguinal canal. It may lie either in front of or behind the peritoneum, though the retroperitoneal position is the more common. If situated in front of the peritoneum it may be held in on the other side by the fibrous layers of the muscular wall. It may, however, push in between the muscle layers of the abdominal wall, and cases have even been reported where the hydrocele was entirely superficial to the muscles.

Patients with interstitial hydrocele usually seek medical aid because of a swelling in the abdomen, and the examiner is not at once likely to think of hydrocele unless he recalls that such a fluid collection, especially when associated with maldevelopment of the testicle, may force its way between the psoas muscle and the parietal peritoneum, pushing the peritoneal fold forward against the anterior wall of the abdomen.

The treatment is similar to that for other hydroceles except that when surgery is employed an abdominal incision is necessary.

**Hydrocele Fluid.** The serous fluid content of a hydrocele resembles ordinary blood serum. It is viscid, odorless, and straw-colored. The occasional presence of cholesterol crystals may give it a glistening, almost opalescent appearance. Its specific gravity is 1.020 to 1.025. Its chief organic constituents are fibrinogen and albumin, but relatively high amounts of alkaline carbonates and sodium chloride indicate that the tunica vaginalis exercises a selective action and that the fluid is more than a mere physical effusion into that membrane. Fibrous bodies are sometimes found floating in the fluid. These are phosphatic or carbonic

concretions, encrusted with fibrinous material. Histologically, they consist of parallel or concentric layers of dense fibrous tissue with a few widely scattered cells of connective tissue between them. A few spermatozoa are occasionally found in hydrocele fluid.

Blood may be present in the fluid constituting a *hematocele*. If there is infection the fluid is cloudy or chylous in appearance. Hydrocele may progress to suppuration, in which case it is termed *pyocele*.

**Symptoms and Diagnosis** Ordinarily, the patient's chief complaint is of the inconvenience occasioned by the size and weight of the mass. Chronic hydrocele is of slow development and usually painless. In acute hydrocele, which is generally secondary to trauma or inflammation, pain may be present or absent depending on the primary lesion in the testicle or epididymis.

A hydrocele usually manifests itself as a pyriform mass, with the larger end below. Above this smooth elastic tumor the spermatic cord can be palpated and the margin of the external inguinal ring defined, thus demonstrating that the swelling is not a hernia. The tumor is dull to percussion and generally translucent. In cases of long standing or in which there has been inflammation the wall may be so thickened as to fail to transmit light and the hydrocele may be taken for a tumor. A hydrocele cannot be reduced into the inguinal canal and gives no impulse on coughing unless complicated by hernia.

When the condition is bilateral the mass will be oblong or rounded instead of pyriform and its size will usually cause considerable stretching of the scrotal skin making it tense shining and perhaps reddened. The penis may be completely concealed. Inability to project the urinary stream in the normal manner may result in inflammation of the skin from dribbling of urine adding to the patient's discomfort.

The wall of the sac may be greatly thickened and calcified in areas. The sac may be multilocular due either to inflammatory adhesions or to the projection of cysts which have formed between the tunica albuginea and tunica vaginalis.

Though hydroceles are frequently painless and may cause little inconvenience apart from their weight, it must always be borne in mind that the pressure induced by the long continued presence of a hydrocele is likely in time to cause atrophy of the testicle.

Three methods of diagnosis are available, which may be used singly or together, as occasion requires. These are the test for translucency, the ability to isolate the tumor and puncture. In true uncomplicated

hydrocele, transillumination will cause the whole tumor to glow with a pinkish light, but the translucency will vary in individual cases, due to the varying thickness of the skin and the sac wall and to the constitution of the contained fluid. The testicle, which usually is situated at the postero inferior aspect of the tumor, as a rule casts a shadow, so that its location can readily be ascertained. During transillumination, the hand which is used to render the hydrocele and skin tense should also keep the fluid from collecting at the bottom or back of the scrotum by squeezing it up above the testicle, where the translucency can be demonstrated.

*Differential Diagnosis.* *Hernia* can be excluded if the spermatic cord can be grasped above the swelling and the unobscured margins of the inguinal ring palpated. Furthermore, a hernia is not translucent, gives an impulse on coughing, and can be reduced into the inguinal canal. Congenital and infantile types of hydrocele, which result from developmental errors, are often very difficult to differentiate from hernia because of the patent funiculus.

*Hydrocele in a hernial sac* is occasionally met with but as there is usually a history of hernia, differential diagnosis should not be difficult. Its proved connection with the abdomen when the tumor can be palpated beyond the external ring, will offset the translucency usually demonstrable.

*Hematocele* may complicate the course of a hydrocele, and is very difficult to differentiate clinically. It frequently results from trauma, in which case the skin will be bruised, but hematocele may exist without injury. Hematocele is less elastic to the touch than hydrocele, heavier, and impervious to light.

*Pyocele* closely resembles hydrocele but the scrotal skin will be red, dened, tender, and edematous, and systemic effects, such as elevation of temperature and rapid pulse, will be present.

*Spermatocele* may be differentiated by the fact that the testicle is situated in front and below, instead of behind, as in hydrocele. Fluid from a spermatocele is whitish and opalescent and microscopically shows spermatozoa, while hydrocele fluid is straw colored and seldom shows spermatozoa.

*Cysts of the epididymis* occasionally complicate the diagnosis of hydrocele.

Differentiation of hydrocele and tumor of the testicle is discussed on page 458.

*Hydrocele of the cord* must be distinguished from congenital and infantile hydroceles, which involve the testicle also and are derived from the



**funicular process** Diffuse hydrocele of the cord is usually much more difficult to diagnose than the encysted variety The latter may be single or multiple, and can usually be distinguished by palpation and translumination

**Treatment** In *acute* hydrocele, palliative measures—rest in bed, elevation of the scrotum, and hot or cold applications—usually suffice Occasionally, tapping of the sac may be necessary Since an acute hydrocele is practically always secondary to a testicular or epididymal lesion, treatment must be directed mainly toward the primary affection When this has been relieved, the hydrocele usually subsides without further attention

*Chronic* hydrocele may be treated in one of three ways (1) by tapping, (2) by aspiration followed by injection, (3) by open operation These procedures are described on page 510

Tapping, in adults, must be regarded as a purely palliative measure, applicable in cases where more effective procedures are refused by the patient or contraindicated by his general condition In acute hydroceles of infants, on the other hand, tapping not infrequently effects a cure

### *Hematocoele*

Hematocoele and its treatment are discussed on page 401.

### *Varicocoele*

Varicocoele is a dilatation, elongation, and tortuosity of the veins of the pampiniform plexus The vein most commonly affected is the spermatic, though not infrequently the deferential or cremasteric veins will likewise be involved The condition is bilateral in about 5 per cent of cases

**Etiology** The etiology of varicocoele has been the subject of considerable speculation Anatomical factors undoubtedly enter in It will be recalled that the pampiniform plexus is formed of three groups of veins the spermatic (anterior) group, the deferential (middle) group and the cremasteric (posterior) group The right spermatic vein opens obliquely into the vena cava, but the left enters the renal vein at a right angle These veins are supplied with valves, but occasionally the valve at the orifice of the left spermatic vein is absent The fact that most varicocoeles (over 97 per cent) occur on the left side suggests that the right angled entry of the left spermatic vein into the renal vein and the occasional absence of the valve on this side predispose to their formation

These veins are surrounded only by a loose envelopment of fascia,

and are dependent and practically unsupported—conditions which readily lend themselves to pathological accident

The most generally accepted explanation of varicocele, however, is that it is caused by chronic passive congestion induced by unrelieved sexual stimulation. This is borne out by the fact that the vast majority of patients are young unmarried men between the ages of 15 and 30 years, the highest incidence being between 20 and 25 years—the period of highest functional development of the sexual organs. As a rule, the condition disappears after marriage or with advancing years.

Certain abdominal conditions, such as tumor of the kidney or a large hydronephrosis, sometimes cause varicocele by mechanical obstruction of the spermatic vein.

**Pathology** Veins may be encountered in any degree of dilatation and tortuosity, even to the stage where there is complete breakdown of the valves, with atrophic and greatly thickened vessel walls. Phleboliths are sometimes found in the veins. The time worn phrase 'like a bag of worms' best describes how a varicocele feels to the palpating fingers.

**Symptoms and Diagnosis** In many cases symptoms are entirely absent, and the condition is spontaneously relieved by the passage of time. Other patients complain of a heavy, dragging feeling, sometimes accompanied by neuralgia of the testicle. Neurasthenic symptoms are common, and may be the only symptoms present.

Diagnosis is usually easy, the feel of the enlarged veins being so characteristic as to be almost certain of recognition. The testicle on the affected side hangs lower—often so low as to cause a constriction in the scrotum above the gland. The scrotum itself is pendulous, relaxed and smooth, the varicocele frequently being visible either as a tumor in the upper part or as a well defined mass surrounding the testicle, the greater part of the tumefaction being below the gland. Lifting up the scrotum, with the patient prone, will cause the varicocele to empty, but as soon as he stands erect it will refill, and this may be hastened by the examiner placing his finger lightly upon the external inguinal ring. A varicocele induced by an abdominal tumor does not empty, but remains distended—an important differential point.

**Treatment** In most cases of varicocele surgical intervention is not only unnecessary but unwise. Most varicoceles spontaneously disappear with the passage of time. Those men who have varicocele and are neurasthenics in addition—and they are many—are rarely relieved of their neurasthenic symptoms by the operation, and in the excision

and ligation of the thin walled dilated veins there is always danger of hemorrhage, which may be followed by thrombosis, hematoma, epididymitis, or atrophy of the testicle. It is not unusual for hydrocele to follow the operation, leaving the patient worse off than he originally was. If hernia exists in conjunction with varicocele, the danger of epididymitis, testicular atrophy, and secondary hydrocele is greatly increased by excision of the varicose veins during the radical removal of the hernia.

Therefore, except in cases where the veins are markedly enlarged, the patient should be informed of the harmlessness of the condition, advised as to his sexual hygiene, instructed to immerse the scrotum frequently in cold water and to support it with a suspensory, and treated for neuralgia of the testicle if this is a feature of his condition.

Acute varicocele, which may occur suddenly after muscular effort, usually subsides quickly with rest in bed, cold applications, and elevation of the scrotum.

Operation consists in (1) ligation and excision of the involved veins, or (2) injection of the varicose veins. These procedures are described on page 514.

### *Spermatocele*

Spermatoceles are retention cysts within the scrotum which contain spermatozoa. They arise from the vas efferens, vas aberrans, or the appendix testis. Other cysts commonly found in the region of the testicle and epididymis do not contain spermatozoa—an important point in differential diagnosis. The presence of spermatozoa in the fluid indicates that the cyst is or has been, in communication with the seminiferous system.

**Etiology** Etiological factors mentioned by various authors are gonorrheal epididymitis, sexual excitation without gratification, and various other inflammations and stimulations to which the scrotum is subject. A history of previous trauma is frequently forthcoming, but active men are likely to incur blows in the scrotal region, and even if the patient is positive that the swelling appeared immediately after the traumatic accident, such an explanation should not be accepted without a searching examination.

**Pathology** The spermatocele is a true retention cyst because it originates in a cavity already formed. It is lined with the same epithelium as the cavity from which it arises, and its contents are biologically similar. An extravaginal cyst lies above the epididymis, an

intravaginal cyst, between the testicle and epididymis, displacing the testicle downward and forward

In size, spermatoceles may vary from that of a small pea to that of a baby's head, but the majority are relatively small

*Contents of Cyst* The fluid contained in a spermatocele is usually of a grayish white color, resembling milk in appearance and consistency. Microscopically, it displays not only spermatozoa but also fat globules, lymphocytes, and epithelial cells. The spermatozoa may be active, but usually are lifeless. In cysts arising from a senile testicle they may be wholly absent. The reaction of the fluid is neutral or faintly alkaline, its specific gravity light (1.002 to 1.009), and its albumin content from 0.2 to 0.5 per cent. Huggins and Johnson have called attention to the total absence of phosphorus and the small amount of sugar found in their analysis of spermatocele fluid.

*Symptoms and Diagnosis* The patient's chief complaint is usually of a tumor in the scrotum, which he may believe to be a cancer, a hydrocele, or even a supernumerary testicle. His anguish will be purely mental, however, for until it reaches a large size spermatocele is not painful and at no time is pain acute. Great distention of the sac may cause a heavy dragging sensation.

The tumor appears as a globular mass above the testicle if extravaginal, and as a piriform mass displacing the testicle downward and forward if intravaginal. Hydrocele frequently coexists.

Diagnosis should not be difficult, since the finding of large numbers of spermatozoa is positive evidence of spermatocele. It must be remembered, however, that spermatozoa are sometimes found in small numbers in hydrocele fluid and that occasionally they may be absent from spermatocele fluid.

Physical examination alone may not enable the diagnostician to tell whether he is dealing with spermatocele or with hydrocele, chylocele, gonorrheal epididymitis, certain atypical cases of varicocele, serous cysts of the epididymis, or a solid tumor of the testicle or epididymis.

The age of the patient is of no diagnostic assistance, as spermatocele may occur at any time after puberty, though the incidence appears to be greatest in late middle life.

*Treatment* Small spermatoceles require no treatment. For larger cysts, surgical extirpation (p. 513) is the method of choice. Simple aspiration is invariably followed by recurrence, but aspiration followed by the injection of irritants, a once popular method, appears to be ex-

experiencing a revival of interest. The technic and solutions employed are the same as for hydrocele (p 511)

### *Sterility in the Male*

Sterility is inability of either the male or the female to reproduce. The most important step in its treatment is the determination of the causative factors.

**Etiology** In the male, fertility is dependent upon (1) the production of healthy spermatozoa, (2) free transmission of the uninjured spermatozoa to the urethra, (3) the ability to have successful coitus.

Faulty spermatogenesis is the result of absence or inefficiency of the testicle itself. This may be due to castration, a congenital abnormality, such as agenesis or cryptorchidism, acquired atrophy or destruction of the testicle, following trauma, inflammatory or malignant disease, or exposure to certain physiotherapeutic agents such as deep x ray, constitutional depression, endocrine dysfunction, or vitamin deficiency. Atrophy of the testicle is a common sequela of torsion of the cord, the orchitis of mumps, cryptorchidism in which treatment has been delayed until after puberty, and operations for hydrocele, varicocele, and hernia. If the condition is bilateral, complete sterility results.

Sterility may also result from mechanical obstruction of the genital tract. Such obstruction may be in the epididymis, vas deferens, or ejaculatory duct. Normal spermatozoa are produced by the testicular cells, but occlusion of the seminiferous pathways, by congestion and infiltration or stricture, prevents their transmission to the urethra. In order for the sterility to be complete, such blockage must be bilateral.

The most common cause of blockage of the genital passages is gonococcal, tuberculous, or non specific infection. The preliminary congestion is followed by distortion due to scar contraction, completely occluding the genital tract in a considerable percentage of cases. The globus minor of the epididymes and the adjacent portions of the vasa deferentia are the areas where the scar tissue is likely to be most dense.

Sometimes the spermatozoa are injured in their passage through the genital tract by abnormalities of the prostatic or seminal vesicular secretions, or by infection. The temporary azoospermia thus produced usually disappears as the condition in the prostate and vesicles clears up under treatment. Temporary azoospermia may also take place as a result of sexual overactivity.

Impotence and malformations of the external genitalia, such as hypo

spadias, are the most common causes in the male of defective intercourse, with, consequently, inability to effect union between sperm and ovum.

**Diagnosis** The three main steps in the diagnosis of sterility in the male are (1) the history, (2) physical examination (3) examination of the semen.

Both the history and physical examination are of great importance in seeking to discover the causative factor or factors of sterility. Careful correlation of the clinical data with the findings of microscopic examination of the semen will invariably enable the examiner to tell whether or not the husband is entirely or partially responsible for a barren marriage. It is important to ascertain whether the patient has any abnormal habits or has had disease such as gonorrhea, mumps, orchitis, epididymitis, and prostatoseminal vesiculitis, torsion of the testicle, orchidopexy, or operation for bilateral hydrocele, varicocele, or hernia. Physical examination, which should include the usual general examination, inspection of the genitalia, examination of the urine, and rectal palpation will show congenital or acquired defects of the external genitals if present, arrested secondary sex characteristics, and urogenital infection.

Microscopic appraisal of the semen is the chief index of male fertility. This may be accomplished by stripping the seminal vesicles or, more accurately, by examining a condom specimen shortly after intercourse.

Following abstinence of one week, the ejaculate is collected and kept in a clean glass bottle at room temperature until delivered within an hour or two, to the examiner.

Examination consists in estimating the volume, turbidity, viscosity, pH, motility, viability, and number of sperm per cubic centimeter and in morphological study of a stained smear.

A normal specimen contains from 3 to 4 cc of ejaculate, is turbid, and has a pH ranging from 7.7 to 8.5. The semen may be thin and watery, or thick and viscid. The average fertile male produces from 100 million to 150 million spermatozoa per cubic centimeter or from 400 to 600 million in the total ejaculate. The studies of Robert S. Hotchkiss indicate that the more reliable cell counts are on the basis of the cells present in the total volume of the ejaculate rather than in units of cubic centimeters. Interval examinations are made of the sperm, to study its viability, which, at room temperature, is usually 24 hours.

The examiner must be familiar with the morphological variations of the spermatozoa. They may be sluggish or aggressive, non motile, imperfectly developed, very scarce (oligospermia), or entirely absent.

(azoospermia) Absence of all semen is termed aspermia. The extensive studies of Moench have lead him to believe that if the sperm morphology count shows more than 20 per cent of abnormal cells, sterility will result.

Having ascertained the absence of spermatozoa, the examiner must next determine whether it is due to inefficiency of the testicle itself or to some fault of transmission. Urethroscopic inspection of the posterior urethra and verumontanum, catheterization of the ejaculatory ducts, and the taking of vesiculograms (by retrograde injection or vasopuncture) are frequently of great aid in locating the cause of sterility dependent upon a prostatovesiculitis or stricture of the vasa deferentia or ejaculatory ducts.

**Prognosis** Sterility due to congenital abnormality, or to acquired atrophy or destruction of the testicles, is hopeless. Sterility due to mechanical obstruction of the genital tract by stricture or congestion, or to injury of the sperm in its passage through the tract, or to constitutional depression or functional impotence, will frequently respond to proper treatment.

**Treatment** The treatment depends on the cause. True azoospermia, such as that due to agenesis atrophy, castration, etc., is usually hopeless. Testicular implants, transplants and grafts have invariably proved futile. Azoospermia due to constitutional depression frequently clears up with improvement in the general health. The prognosis in sterility due to endocrinological disorders has improved in recent years, and better results may be anticipated with increasing knowledge and the purification of gonadotropic hormones. Vitamin deficiencies may respond to dietary measures. Sterility due to occlusion of the ejaculatory ducts and vasa deferentia from congestion without true stricture, usually disappears with subsidence of the infection and reestablishment of patency of the ducts.

Sterility due to bilateral obliterating epididymitis may sometimes be relieved by epididymo vasotomy, this is described on page 505.

### *Diseases of the Scrotal Contents in Children*

The conditions one primarily bears in mind in the examination of boys of any age are undescended testicle, ectopic testicle, hydrocele, and tumor of the testicle. Tuberculous epididymitis occasionally may be present.

Children under 4 years of age do not stand operation well. It is there

fore our custom, in cases of undescended testicle that do not respond to hormonal therapy, to operate for its reduction soon after the fourth birthday. In cases of tumor and tuberculosis the operation must be done as soon as the diagnosis has been made.

Hydrocele of the tunica vaginalis occurs frequently in children who have worn a truss for hernia, as well as in tuberculous epididymitis and after traumatic injury to the scrotum or its contents. In the rare instances in which the hydrocele is of sufficient size to cause serious annoyance, excision of the sac should only be done after palliative measures—including repeated aspirations of the fluid—have proved ineffective.

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## CHAPTER XII

### OPERATIVE AND NON-OPERATIVE TREATMENT OF THE SCROTUM AND SCROTAL CONTENTS

#### A OPERATIVE TREATMENT OF THE SCROTUM AND SCROTAL CONTENTS

##### *Anesthesia*

For older boys and adults we prefer spinal anesthesia for operations upon the scrotum and the scrotal contents. If spinal anesthesia is for any reason contraindicated, and local infiltration of novocaine, 1 per cent, is unsatisfactory, general inhalation anesthesia (with cyclopropane, ethylene, nitrous-oxide-oxygen, or open drop ether) may be used or avertin in small doses reinforced by gas. Sodium pentothal or evipal, administered intravenously, is too transitory in its effect to be utilized except for incision and drainage. General inhalation anesthesia is usually necessary for children.

These various types of anesthesia are described in the chapter on Anesthesia in Urology (p. 190).

##### *Preoperative Preparation of the Patient*

The usual preoperative purgative is given late the night before operation if the patient is to be operated on in the afternoon and earlier if he is to have an early operation. Castor oil (45 cc.) is best. Two hours before operation a soapsuds enema is given. This preparation is usually effective in preventing postoperative distention.

The external genitalia and groins are carefully shaved thoroughly scrubbed with soap and water, and covered with dressings until the patient is taken to the operating room.

A sedative, such as phenobarbital or nembutal (0.1 Gm.) is given the evening before operation. An hour before going to the operating room the patient is given 0.2 Gm. of the drug (Preliminary Medication p. 191).

On arriving at the operating room the patient is anesthetized and the final preparation completed. The parts are again scrubbed with soap and water, sponged off with alcohol 70 per cent, and then sprayed with



merthiolate, 1 1,000, or tincture of zephiran, 1 1,000 Iodine should not be used for sterilizing the scrotum, as it is sufficiently irritating to cause excoriation of the tender scrotal skin

### *Operative Treatment of Cryptorchidism and Ectopic Testicle*

**Indications for Operation** Indiscriminate sacrifice of the undescended or ectopic testicle is unwarranted since, with care, most of these organs can be satisfactorily reduced and the accompanying hernia repaired Even atrophic testicles with questionable spermatogenesis, should be conserved for the influence they may exert on the development of the secondary sex characteristics

Many undescended or partially descended testes will descend spontaneously, usually before or at puberty True undescended and ectopic testes cannot descend because of mechanical factors present, and require surgical correction

Relatively early operation, in those cases in which the testis or testes fail to descend spontaneously, is important for a number of reasons (1) The scrotal position appears to be necessary for the complete anatomical and physiological development of the testicle, (2) the undescended testicle is more liable to suffer trauma, torsion, and malignant degeneration than the normally placed organ, (3) the accompanying inguinal hernia, if left untreated, is a potential danger to life, (4) acute infections in an undescended or ectopic testis are even more distressing and menacing than those in the normally placed gland, (5) the nervous disorders and neurotic states that often accompany these anomalies usually clear up following reduction of the testicle to its normal position

**Age at Which to Operate** While there is general concurrence among authors that the attempt to reduce the testicle should be made during childhood, opinions differ regarding the age at which the operation can be carried out with the greatest safety and assurance of success

In cases of true undescended or ectopic testes positively diagnosed by palpation, operation should be done as soon as the boy has reached a safe surgical age It is our opinion that children under 4 years of age do not stand operation well, but that any time after that age is suitable for surgical correction of these anomalies, when surgery is deemed advisable If orchidopexy is performed before puberty, one may expect the undescended testicle to be equal or nearly equal in size to its normally placed fellow, but if operation is delayed beyond puberty, the testicle

will usually be found to be atrophic and incapable of spermatogenesis

The intra abdominal testicle which cannot be palpated, presents a more difficult problem. If the testicle has not descended by puberty or shortly after an exploratory operation should be done. At operation, very careful search must be made for the testicle which may be ectopic and located with difficulty.

**Technic of Orchidopexy** Orchidopexy to be successful must (1) preserve the blood and nerve supply of the testicle (2) fix the testicle in the bottom of the scrotum without undue traction upon the cord and (3) cure the hernia that almost always accompanies the cryptorchidism.

Many operations for the correction of undescended testicles have been devised. In most common use are the procedures of Bevan and Torek and various modifications of these procedures. In the former, retraction of the testicle is prevented by a purse string suture at the neck of the scrotum. In the latter the testis is sutured to the fascia lata of the thigh from which it is detached and the scrotum and thigh separated at a later operation.

The following is the method preferred by us.

The patient is placed on the table in the dorsal position. An incision is made over the inguinal canal and the testicle isolated after incising the aponeurosis of the external oblique in the roof of the inguinal canal which is left wide open. The cremaster is separated and preserved for use in the repair of the hernia which inevitably accompanies the condition. The testis and the veins are then freed from the surrounding fibrous tissue. This is accomplished by carefully unrolling the vessels from the wall of the hernial sac and from the encompassing bundles of fibrous tissue. Experience has taught us that the vas deferens is always sufficiently long to permit the testis to be reduced without undue traction—the organ being retained in its anomalous position by the connective tissue.

The scrotal bed is prepared by breaking up any adhesions with the finger.

Having liberated the testicle and its vessels a suture of chromic catgut No. 2 is then carefully inserted in the fibrous tissue near the epididymis and the long straight needle grasped with a clamp and forced through the scrotal skin at the lowermost part of the scrotum. The catgut is then attached to the skin of the thigh well down so that the cord is on the stretch. The catgut absorbs within 5 to 7 days.

The hernial sac is tied off with plain catgut No 2 and the hernia repaired with chromic catgut, without transplantation of the cord and using the cremaster as an aid in the repair. The skin is repaired with silk,

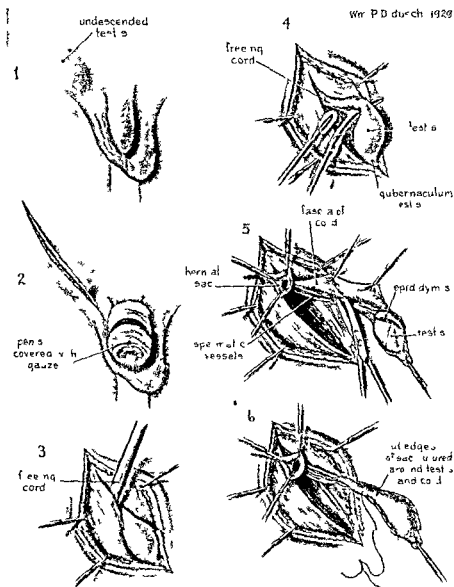


FIG 87 Orchidopexy (2 3 4) An incision is made over the inguinal canal the aponeurosis of the external oblique incised and the cord freed and the testis lifted out of its bed (5) A hernial sac is discovered. This is dissected free and the blood vessels carefully unrolled from the fascia of the cord. This includes a separation of the fibrous structures between the vessels themselves carefully protecting the vas (6) The cut edges of the sac are sutured around the testis and cord.

silkworm gut, or dermal sutures. No drainage is necessary in this operation.

1 = P.D. duchen 1929

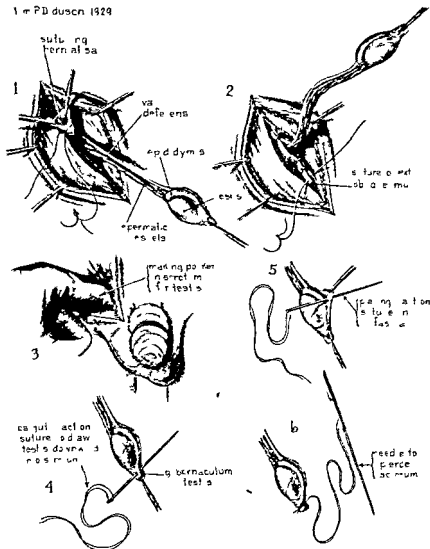


FIG. 88 Orchidopexy (1 2) The hernial sac is closed and the external oblique muscle sutured using chromic catgut (3) A sac is made in the scrotum for the reception of the testicle with its now elongated cord (4) A chromic catgut traction suture is placed in the gubernaculum testis—or fascia (5) for the purpose of drawing the testis into the scrotum.

A viable testicle, permanently retained in the scrotum well below the spine of the pubis is the criterion of success in this operation.

**Torek Technic of Orchidopexy** An incision is made through the skin

and aponeurosis of the external oblique muscle identical in location and extent with that employed in the operation for inguinal hernia

The testis is freed by removing the gubernaculum, cremaster, and any other tissues that may be attached to it. Of the cord the only structures that must be preserved intact are the spermatic blood vessels and the vas deferens. All other tissues are removed, including the vaginal process. If there exists a congenital hernia, it is found in the vaginal process. When there is no hernia, but only an empty, obliterated vaginal process, it is cut off and the stump allowed to slip back into the abdomen. If there is a hernia or an open communication with the peritoneal cavity, the sac is tied before being amputated. The vas deferens and blood vessels are denuded of all their connective tissue coverings till they are the sole remnants of the cord—the dissection of the vessels always extending as high up as the transversalis fascia, and even higher if they are not yet long enough. Completely freeing the blood vessels gives them greater length, so that the testis can be brought down into the scrotum without any traction.

The site for the incision in the thigh is determined by taking the testis out of the inguinal wound and laying it on the thigh without any traction beyond that which is necessary for straightening out the vessels. A point somewhat higher than the one to which the testis reaches is chosen for the incision in the thigh. The testis is then returned into the inguinal wound. The incision is made in a direction following the natural lines of the skin and therefore is in a general way transverse, the inner end slightly lower than the outer. The incision should be of sufficient length to accommodate the long diameter of the testis, and is deepened until the fascia of the thigh is exposed.

A pocket is now made by gently digging with one or two fingers from the lower end of the inguinal incision through the loose connective tissue to the bottom of the scrotum. Here the pocket is opened by an incision which corresponds in length and direction precisely with that in the thigh. As the channel thus established will collapse when the fingers are removed, a tape is drawn through it.

The upper edge of the thigh wound is now sutured to the corresponding edge of the scrotal wound with catgut. When these two edges are approximated for suturing the operator finds the raw surface of each of the two flaps turned toward him and the skin side away from him—exactly the opposite of the relations in the ordinary skin suture. If now the usual procedure for inserting the sutures were followed namely from surface to depth on the first edge and from depth to surface on the second

edge, the knot of the suture would lie on the raw surface. As it is preferable, however, to place the knot on the skin surface, the suturing is reversed, namely from depth to surface at the first edge and from surface to depth at the second edge. Interrupted stitches are used. Safe healing of this suture line requires a sufficient amount of raw surface of each flap to be adapted. To accomplish this the relation of the points of entry and exit for the needle should be such that on the skin side the stitch hole is much closer to the edge than on the raw side, thereby preventing the skin from turning in, which the skin of the scrotum is particularly prone to do. On the scrotal side therefore, this rule is more imperative than on the side of the thigh. Were the skin permitted to roll in, there would be no union wherever it is inverted. The proper application of the sutures is of great importance for, after they are placed, it is impossible to correct a faulty adaptation of the edges.

The testicle, which is lying in the inguinal wound, is now brought down through the scrotal channel, through which a tape has been passed. A curved clamp is made to grasp the tape and with its guidance is drawn up till the tip of its jaw appears in the inguinal wound. The tunica of the testis is grasped and the testis is drawn down so as to emerge from the scrotal wound. Two sutures of fine chromicized catgut are carried through the tunica albuginea testis and the fascia of the thigh, with care not to injure the femoral or saphenous vein. Both sutures are inserted before either is tied, as the tying of one may render the insertion of the other difficult.

The attachment of the testis to the fascia having been completed the anterior lip of the scrotal wound is sutured to the lower edge of the thigh wound with fine silk.

The inguinal wound is now closed the first layer being the attachment of the internal oblique and transversus muscles to Poupart's ligament. The aponeurosis is next sutured, and finally the skin. With the aid of dressing forceps a small strip of gauze is drawn carefully through the channel of skin between the scrotum and thigh, this serves as a dressing for the deep skin suture.

*Releasing the Testis* The testis may be released when the scrotum has stretched out to near the normal size—usually in 2 or 3 months. The incision through the scar should go no deeper than the thickness of the tissues that have been united—that is through the skin and superficial fascia. The flaps are then lifted, the scrotal flap only to a slight extent, and the testis is laid bare mostly by blunt dissection. The division of the posterior part of the scar will usually have to be deferred until the under

lying tissues have been separated from it. The testis is then buried in the scrotum, and both wounds are closed by sutures.

In bilateral retention only one testis is brought down at a time, as the rudimentary scrotum could not be fastened to both thighs without great

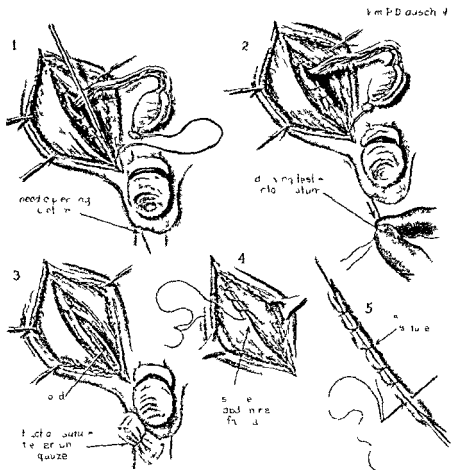


FIG 89 Orchidopexy (1 2) The needle is pushed through the lowermost part of the scrotum with the hemostat drawing the testis into the scrotum (3) The traction suture in the illustration is tied around a piece of gauze but we now fasten it to the inner surface of the thigh thereby obtaining greater traction (4 5) The abdominal fascia and skin are sutured without drainage

danger of tearing loose the sutures. The second testis is brought down at the same time that the first one is detached from its thigh.

**Correction of Ectopia Testis** The ectopic testicle is readily handled as a rule. If it has migrated to the thigh, perineum, or other remote position, the cord is frequently of sufficient length to permit its easy reduction into the scrotum. If, however, the cord is too short, it is

**Technic** The patient is prepared and anesthetized as described on page 486 and placed in the dorsal position on the operating table

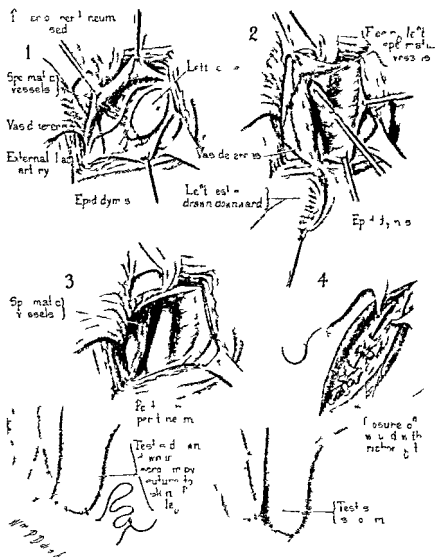


FIG 92 Case of bilateral ectopic testis. Left orchidopexy (1) Posterior pentoneum incised exposing the left testis vas deferens and spermatic vessels (2) Freeing the spermatic vessels (3) The testis is drawn down into the scrotum and held there by a suture placed in the skin of the thigh (4) Suture of wound with ribbon gut (Case of Dr. Lowrey and Dr. E. A. Cann)

A 5-cm longitudinal incision is made in the scrotum over the affected testicle. Through this the testicle is isolated and carefully examined.



If it is possible to untwist the cord, the testicle may be stitched to the scrotum with chromic catgut in such a way that the torsion cannot recur. Ordinarily, however, it is necessary to remove the gland.

The vas deferens is ligated, divided, and the ends touched with carbolic acid, 95 per cent, followed by alcohol, 70 per cent. A transfixion suture of plain catgut No. 2 is placed through the cord and tightly tied.

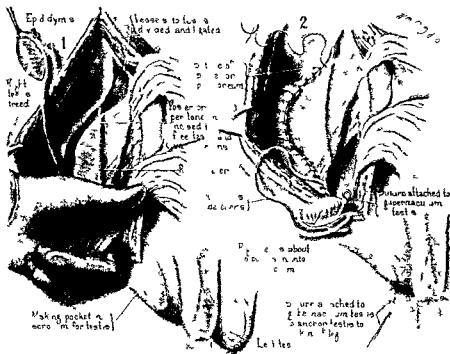


FIG. 93 Bilateral ectopic testis. Reducing the right testicle to its normal position in the scrotum. (1) Freeing the testis and vas deferens, and making a pocket in the scrotum to receive the gland. (2) Drawing the testis into the scrotum by a suture attached to the gubernaculum testis. The suture is then attached to the skin of the leg. (Case of Dr. Lowley and Dr. E. A. Cann.)

completely around the cord. The testicle and distal part of the cord are then excised, leaving a sufficient rosette of tissue to prevent retraction of the vessels. The scrotum is closed in layers, silk or dermal being used for the skin, and a small drain of rubber tissue allowed to remain for a day or two.

**Postoperative Care.** In addition to the usual postoperative care in scrotal cases, the after care consists in removing the drain at the proper time and in observing the condition of the testicle, if the patient is so fortunate as to have it left *in situ*.

*Orchidectomy for Prostatic Carcinoma*

The method which we use in performing orchidectomy on patients who have cancer of the prostate is a modification of that suggested by Dr Elmer Hess of Erie, Pennsylvania

**Technic** The testicle is exposed in the usual manner, and an incision is made in the tunica albuginea Pressure is made on this, and the testicular substance pops out of the tunica (just as a grape would pop out of its skin under similar pressure), leaving the testicle attached at its upper portion at the site of the rete testis This is clamped and tied off, and the testicle is then cut away

After experiments on dogs, O S Lowsley, Aldo Franceschi, and Alejandro Paloma implant bits of fat in the tunica albuginea in the space formerly occupied by the seminiferous tubules The tunica is then closed with catgut and the scrotum is closed in layers The fat remains in the tunica in perfect condition and the cosmetic effect is excellent

There is thus left in the scrotum a considerable mass of tissue, including the epididymis and the tunica albuginea, which has a very desirable psychic effect on the patient

*Radical Operation for Tumor of the Testicle*

**Technic** This procedure consists of two stages (1) orchidectomy and biopsy, (2) removal of the abdominal lymph channels and nodes of the affected side through an abdominal incision

The patient is prepared and anesthetized in the usual manner (p 486) and placed on the table in the dorsal position

The testicle is isolated with as little handling as possible, and if observation bears out the impression of malignancy, orchidectomy (p 495) is performed and the specimen immediately subjected to frozen section examination If the diagnosis is verified the surgeon proceeds to the second stage of the operation (Figs 95 and 96)

For this the patient is placed on the table so that the affected side is slightly elevated—that is he lies partly on his back resting upon a pad placed beneath the costal margin with shoulder and hip upon the table The operative site is prepared by scrubbing and the application of the desired antiseptic solution and the patient properly draped The skin incision extends from the costal margin to the inguinal canal the lower end being deflected obliquely downward to the middle line across a part or all of the rectus muscle This incision is deepened through the

underlying structures to, but not into, the peritoneum, which is stripped back carefully, exposing the chain of lymph nodes extending from the internal inguinal ring along the spermatic vessels, and covering the internal iliac, the aorta on the left side, and the vena cava on the right. The areolar tissue and lymphatic channels and nodes are dissected out to the level of the renal vessels.

The tissue removed is subjected to microscopic examination.

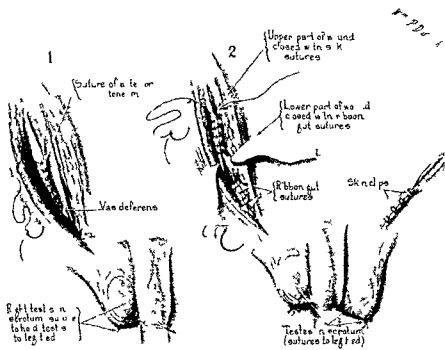


FIG 94 Bilateral ectopic testis (1) Right testis in scrotum suture to leg tied. Closure of anterior peritoneum (2) Showing both testes in the scrotum. Closure of lower part of wound with ribbon gut, upper part with silk sutures and skin with skin clips (Case of Dr Lowsley and Dr E A Cann)

The wound is closed in layers, interrupted sutures of plain catgut No 2 being used in the muscle layers, chromic catgut No 2 in the fascia, and silk, silkworm gut, or dermal for the skin.

**Postoperative Care** As a rule, there is very little shock accompanying this operation, and after 2 weeks in bed the patient is allowed up. He may exercise after 4 or 5 weeks. For the usual postoperative care of scrotal cases, see page 516.

The most important after care of this type of case consists in deep

x ray therapy a thorough course being given with the object of causing necrosis of any stray cancer cells

Mr P. D. W. 19 9

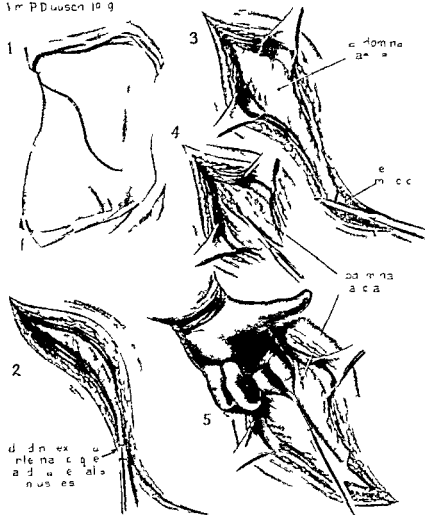


FIG. 93. Radical operation for tumor of the testis. Extirpation of the lymph nodes (1 2 3) An S-shaped incision is made in the skin and deepened through the underlying structures (4 5) The abdominal fascia is incised

### *Epididymotomy*

Epididymotomy may be of two kinds *closed* or *open*

### CLOSED EPIDIDYMYCTOMY

**Technic** Closed epididymotomy consists of making puncture wounds in the affected part of the organ with needles inserted through the skin, without exposure of the epididymis. This is accomplished by holding the testicle and epididymis firmly in one hand while multiple punctures

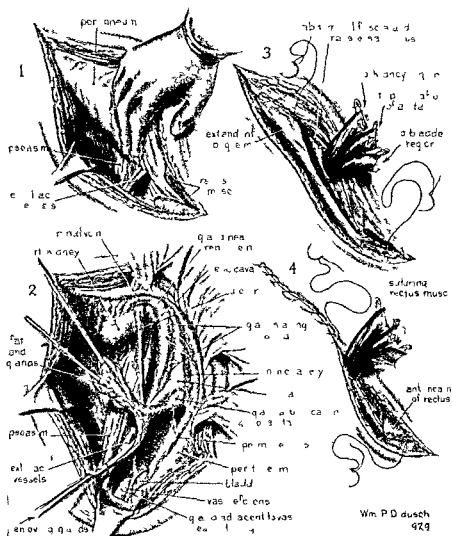


FIG 96 Radical operation for tumor of the testis. Extirpation of the lymph nodes. (1) The peritoneum is stripped back, exposing the psoas muscle. (2) The lymphatics extending from the internal ring along the vessels to the level of the kidney pelvis are stripped off the great vessels to which they are intimately attached. (3, 4) The wound is closed in layers with drains down to the operative site.

are made with a straight needle with the other hand. It is not necessary to make more than one puncture hole through the skin, as the skin is freely movable and all parts of the epididymis may easily be reached.

#### OPEN EPIDIDYMYTOMY

The patient is prepared in the usual manner (p. 486) and placed on the table in the dorsal position.

**Technic** The testicle and epididymis are held in such a manner that the scrotal skin is stretched tightly over them. An incision, 5 cm. long, is then made through the skin, subcutaneous tissue, and tunica, and the tunica vaginalis evacuated so that the inflamed epididymis can be inspected. The testicle and attached epididymis are delivered through the incision and carefully protected.

A single incision, or multiple incisions, into the affected part of the epididymis may be made with the scalpel, or multiple punctures may be made with a large, straight needle. It is important to thrust the incising instrument down deeply enough to enter the infiltrated connective tissue beneath the thickened capsule. The testicle and epididymis are then reduced, and the wound closed in layers with a wick drain.

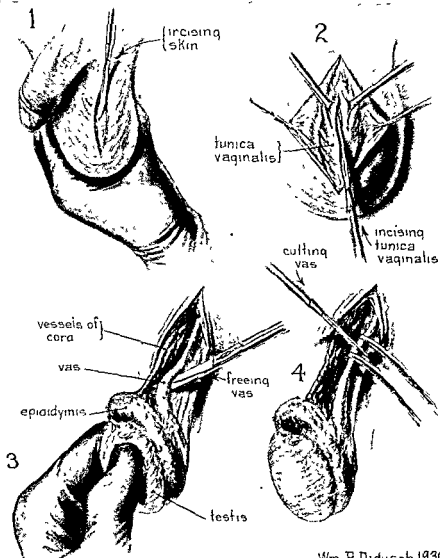
The scrotum is then elevated with a suspensory bandage.

#### *Epididymectomy*

**Technic** The properly prepared and anesthetized patient is placed in the dorsal position, and the testicle and epididymis exposed and delivered as described for open epididymotomy. This is not always easily accomplished as in certain infectious diseases the epididymis is bound tightly to the scrotal wall by adhesions and must be dissected free. This having been accomplished, the vas deferens is isolated, tied off, and divided, the ends being cauterized with carbolic acid, 95 per cent and alcohol, 70 per cent. The proximal end of the vas is then transplanted into the skin of the groin so that discharge from it will pass out on the skin and not pour into the scrotum, reinfesting it (Figs. 97 to 99).

The distal end of the vas is liberated to the point where it joins the epididymis. Dissection of the epididymis proper then begins. The globus minor is freed by sharp and blunt dissection and the globus major is similarly separated. The point where the body of the epididymis curves around the blood supply to the testicle is left until the last in order that it may be thoroughly protected.

All bleeding points are ligated, the testicle replaced in the scrotum, and the wound closed in layers, with a rubber dam drain.



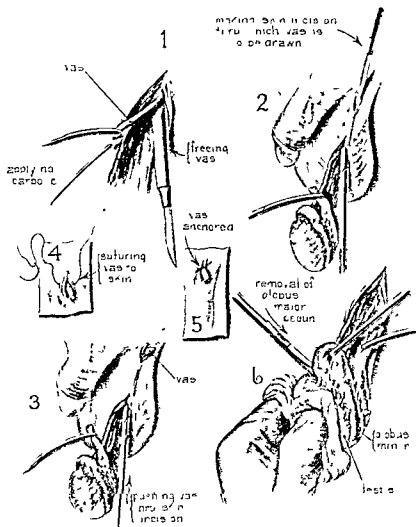
Wm P Didusch 1930

**FIG. 97. Epididymectomy.** (1, 2) The scrotum is grasped by the left hand in such a manner that the skin is stretched tightly over the testicle and epididymis, the skin and tunica vaginalis incised, and the testicle and epididymis delivered through the incision. (3, 4) The vas deferens is freed, clamped, and divided.

**Postoperative Care.** The scrotum is elevated with a bandage and the dressings changed daily, the drain being removed as soon as the flow of fluids stops.

*Transplantation of Vas Deferens to Testicle Following Epididymectomy*

**Technic.** Occasionally it is necessary to remove a diseased epididymis from both testicles, in which case it is advisable to transplant the vas directly into the rete testis at the top of the gland. This is done by dividing the cut end of the vas in such a manner that there are four flaps

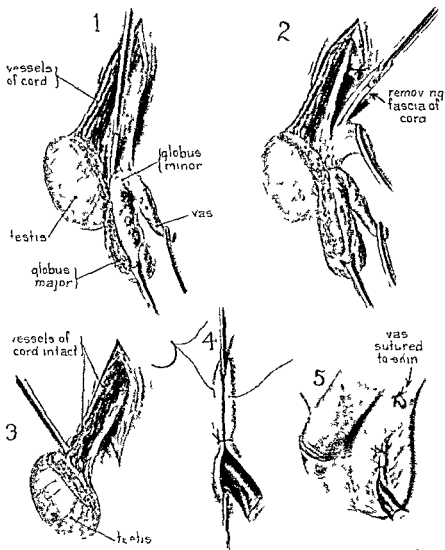


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FIG 98 Epididymectomy (1) Carbolic acid is applied to the cut ends of the vas. (2, 3, 4, 5) The proximal end of the vas is transplanted into the skin of the groin for drainage (6) Dissection of the epididymis is begun



These are fixed to this portion of the testicle by means of four silver wires, as shown in figure 100



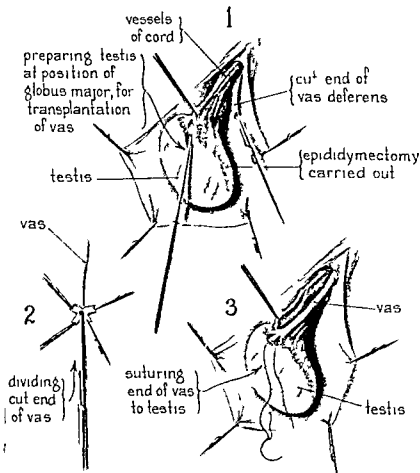
J. N. P. Didwiler 1930

FIG 99 Epididymectomy (1, 2) Continuing dissection of the epididymis (3) Epididymis removed, vessels of cord intact (4, 5) The testicle is replaced in the scrotum and the wound closed, with a rubber dam drain The vas can be seen sutured to the skin

### *Epididymo Vasotomy (Short Circuit Operation) for the Relief of Sterility*

Sterility in the male is frequently a consequence of bilateral occlusion of the genital passages following gonococcal, tuberculous, or non specific

infection (Sterility in the Male, p 475) The area most often occluded is the globus minor of the epididymis and the adjacent portion of the vas. Since spermatogenesis is usually but little affected, it is quite often pos



Wm P Didusch 1932

FIG 100 Transplantation of vas deferens to testicle following epididymectomy (1) The testicle is prepared for the transplantation (2 3) The cut end of the vas is divided into four flaps which are sutured to the rete testis with silver wire

sible to restore fertility by surgical anastomosis of the globus major to an unobstructed portion of the vas, thereby providing a patent canal through which the spermatozoa can pass

Many plastic operations for the relief of sterility due to occlusion

have been recorded in medical literature since Bardenheuer, in 1886, first transplanted the vas under the tunica albuginea of the testicle. The most popular procedure, when the occlusion is in the distal portion

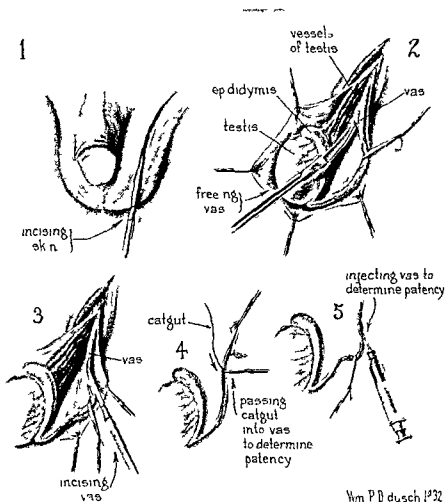


FIG 101 Epididymo vasotomy (short circuit operation) for relief of sterility: (1) A skin incision is made over the distal 5 cm of the vas deferens and the testis (2) The tunica vaginalis has been incised and the testis delivered and the vas is being freed (3) A longitudinal incision about 2 cm long is made in the freed vas (4) A piece of catgut introduced into the lumen of the vas and downward toward the epididymis will show the location of obstruction (5) Methylene blue is injected into the proximal end of the vas to determine its patency

of the vas is vaso epididymal anastomosis using fine silver wire for suture—a technic first reported by Martin in 1902 and later utilized extensively by F R Hagner, who, in 1940, reported a large series of cases

Fine catgut and silk have also been utilized for suturing, but have not proven as satisfactory as silver wire

**Indications for Operation** Before any operation for the reestablishment of patency of the genital tract is undertaken, it must be ascertained (1) that the obstruction is in the distal 5 cm of the vas, (2) that the globus major is patent, (3) that the vas deferens and the ejaculatory duct are patent from the point of contemplated anastomosis to the urethra, (4) that the testicle contains viable spermatozoa and is capable of spermatogenesis (this may usually be determined by needling it), and (5) that there is no acute or subacute inflammatory condition in the genital tract

**Technic** A longitudinal skin incision is made over the vas deferens beginning about 6 cm above the testicle. The incision is deepened down to the tunica vaginalis, which is then opened by a longitudinal incision and the testicle delivered

The vas is freed from the cord and a longitudinal incision about 2 cm long is made in it. A piece of catgut introduced through the lumen of the vas toward the epididymis will demonstrate the location of obstruction. Methylene blue is injected into the proximal end of the vas to determine its patency (unless this has previously been ascertained by roentgenography following the injection of an opaque medium). If the vas is patent, the injection of this substance will cause the bladder urine to contain the characteristic blue color

If the vas is found to be patent, the globus major is aspirated, and the aspirated fluid is studied under the microscope for evidence of spermatogenesis. If spermatozoa are found a small oval opening is made in the globus major (Fig 102). Anastomosis is accomplished by suturing the proximal edge of the epididymal opening to the distal edge of the incision in the vas with a suture of the finest silver wire which must be applied without too much pressure or it will cut through. Silver wire sutures are then placed at the presenting edges of the incisions and a fourth suture closes the wound by attaching the proximal edge of the incision in the vas to the distal edge of the epididymal incision. A malleable wire can be substituted for silver

A suspension suture is placed through the scrotal skin to relieve the tension on the anastomosis sutures

The wound is closed in layers: catgut being used for the subcutaneous tissues and silk for the skin

This procedure permits the discharge of spermatic fluid from the rete

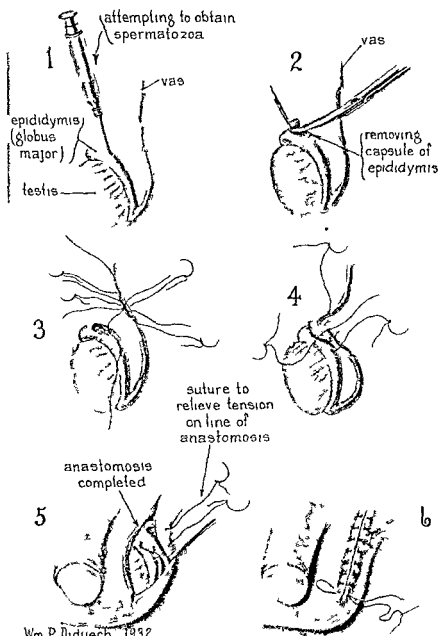


FIG 102 Epididymo-vasotomy (1) Aspirating the globus major to obtain spermatozoa. (2) If viable spermatozoa are found in the aspirated fluid a small oval opening is made in the globus major (3 4) Anastomosing the vas to the globus major with four sutures of finest silver wire (5) Placing a suspension suture through the skin to relieve the tension on the line of anastomosis

testis into the vas. Numerous successes have been reported by various operators on our staff.

### *Radical Removal of Genital Tract for Tuberculosis*

Simple epididymectomy, with transplantation of the vas to the skin of the groin to prevent tuberculous pus from flowing into the scrotum, and with preservation of the testicle unless it is extensively involved (which is uncommon), is the operation of choice for tuberculous epididymitis, and usually suffices.

However, in selected cases, in which there is involvement of the epididymis, vas deferens, and seminal vesicle on one or both sides, complete removal of the genital tract is indicated. This procedure is not justified if the prostate is involved in the tuberculous process.

**Technic.** For this procedure spinal anesthesia is preferable. The operation is, in reality, a combination of epididymectomy, vasectomy, and seminal vesiculectomy.

The epididymis is first removed in the manner described on page 502, and the vas dissected out and ligated as high up as possible. The patient is then placed in an exaggerated lithotomy position and the seminal vesicle exposed (p. 561). By putting sufficient traction on the vas, it may easily be delivered into the perineal wound. The seminal vesicle and ampulla of the vas on the affected side are tied off, excised, and the ends cauterized with carbolic acid, 95 per cent and alcohol, 70 per cent. The perineal wound is closed, with a Penrose drain attached to the site of excision. The wound is dressed and the patient returned to his bed for a period of at least 10 days.

**Postoperative Care.** Postoperative treatment consists of rest in bed, daily dressings, and immediate and daily application of heliotherapy, as well as injections of old tuberculin in regularly graduated doses (Treatment of Inoperable and Postoperative Tuberculosis of the Genito-Urinary Tract, p. 1196). Here, as elsewhere in the care of the tuberculous patient, the after care is an indefinite procedure, and the patient should be kept under the most rigid dietary and hygienic control.

### *Operative Treatment of Hydrocele*

#### SIMPLE TAPPING

A hydrocele, from which hernia has been positively excluded, may be tapped, although in adults this can be regarded merely as a palliative measure, applicable where the injection treatment or open operation is

refused or contraindicated by the patient's general condition. In adults, the fluid usually reaccumulates in a few months, but in infants the procedure may be curative.

**Technic** Aspiration of a hydrocele is accomplished by means of a Luer or similar type of syringe with an 18 gauge needle, 9 cm long. After proper preparation of the scrotal skin and isolation of the testicle, the skin is made tense and the needle plunged into the lower anterior surface of the hydrocele and the fluid withdrawn.

#### ASPIRATION AND INJECTION OF HYDROCELE

The injection treatment of uncomplicated chronic hydrocele, after being disapproved for some time, has recently seen a revival of use, following the successful management, by this method, of varicose veins, hemorrhoids, and similar conditions in other hollow structures. The employment of sodium morrhuate in place of the more irritating and toxic materials previously employed (phenol in particular) has contributed toward this revival of the injection method.

The theory of the procedure is that the introduction of a substance sufficiently irritating to induce an inflammatory reaction in the serous lining of the hydrocele will cause adherence of the sac walls, with its eventual obliteration. The endothelium of the tunica vaginalis is mesodermal in origin. When mesodermal tissue is injured, the repair process consists in the formation of fibroblasts. Thus, fibrous tissue will fill up and replace the cavity occupied by the fluid accumulation.

A too caustic irritant, such as pure phenol, will destroy the endothelial cells altogether, preventing any repair process and defeating the object of the injection. Also the injection of too much fluid, whether of suitable irritant quality or not, will so distend the sac that the walls will be kept apart and adhesion prevented.

Bilocular hydrocele can be treated by injection quite as well as the unilateral single chambered variety, but the method is not likely to be successful in old hydroceles with thickened and indurated walls.

Spermatoceles may also be treated by this method of aspiration and injection.

**Technic** The swelling is first carefully palpated to exclude tuberculosis and malignancy, and should any suspicion of these diseases arise, biopsy must first be done. *Hernia must, of course, be likewise excluded.*

Local infiltration anesthesia is usually ample for this procedure.

The content of the sac is first aspirated, care being taken to see that

it is entirely emptied. The same needle employed for aspiration may be used to inject sterile water for irrigating the cavity, which is a wise precaution before the sclerosing fluid is introduced. When the irrigating fluid has been withdrawn, 4 or 5 cc. of a 5 per cent sodium morrhuate solution is injected through the same cannula. The cannula is immediately withdrawn and a sterile dressing applied to the needle puncture. The scrotum should then be very gently massaged in order to distribute the irritant fluid evenly throughout the sac.

The scrotum is supported, and the patient dismissed for one week. A second tapping is frequently carried out on the eighth day, but in many cases this will be unnecessary as the adhesion of the sac walls will already have occurred.

**Postoperative Care.** The patient should remain in bed for the first 72 hours and should observe care in movement for a full week. There may be a slight reaction after the initial injection, with rise of temperature and general malaise, but this will be of brief duration.

#### OPEN OPERATION FOR HYDROCELE

Open operation is preferable in the majority of cases. The Winkelman operation, in which the sac is almost entirely excised, is less likely to be followed by recurrence than the once popular Andrews 'bottle operation,' consisting of opening and everting the sac.

**Simple Eversion (Andrews "Bottle Operation").** An incision, 8 to 10 cm. long, is made over the most prominent portion of the hydrocele. The sac is opened in its upper portion, and after the fluid has been evacuated and the testicle freed from its fascial attachments, the remainder of the sac is everted, so that the testicle and epididymus are on the outside of the sac, which is then closed by one suture through the neck of the 'bottle' thus formed. The incision in the scrotum is closed by suture, without drainage.

The advantages of this operation are the slight pain, the short convalescence, and the infrequency of postoperative hemorrhage. Recurrence, however, is common, and it is not suited to hydroceles of long standing. *This method is now little used.*

**Excision and Eversion (The Winkelman Operation).** The most acceptable of the various open procedures is the Winkelman operation. The skin and fascia are divided and dissected free from the tunica vaginalis. The parietal layer of the tunica vaginalis is then dissected free,



and the sac trimmed off to within  $\frac{1}{2}$  inch of its visceral insertion. The cut edges are joined behind the testicle with a whip suture. Extreme care must be exercised to secure all vessels that might give rise to subsequent hemorrhage and postoperative hematoma.

Following hydrocelectomy (and almost every operation within the scrotum), it is important that a drain be inserted, in order that excess serum and blood may be carried off. Unless drainage is instituted, the areolar scrotal tissue will absorb the excess fluids, resulting in tremendous increase in the size of the scrotum and requiring several weeks for absorption. This is extremely trying to the patient, who starts out with a hydrocele—a soft mass in the scrotum—and finishes his stay in the hospital with a hard swelling, which eventually absorbs but in the meantime causes both patient and surgeon considerable anxiety.

**Postoperative Care.** The postoperative care is that usually accorded scrotal cases (p. 516). The possible complications of operation for hydrocele should be borne in mind: hemorrhage and hematoma, atrophy of the testicle (rare), and recurrence of the hydrocele.

### *Amputation of the Redundant Scrotum*

Opinions vary as to the advisability of resecting the redundant scrotum. This procedure, once a common preliminary to operation for varicocele, is now seldom done, but may occasionally be indicated in very large hydroceles or when, for any reason, the scrotum has become greatly relaxed and stretched out.

**Technic.** The operation consists in cutting away the redundant portion of the scrotum with curved scissors or a scalpel, hemorrhage being controlled by digital pressure or by one of the numerous clamps devised for this purpose. After all bleeding points have been carefully ligated, the edges of the wound are sutured together, with drainage.

Hemorrhage must be thoroughly checked, or hematoma will inevitably result in the highly vascular scrotum.

### *Extirpation of Spermatocoele*

**Technic.** The cyst is brought out through a longitudinal incision in the scrotum, and, if small, extirpated in its entirety. If large, the cyst is incised, its contents evacuated, and the wall carefully resected (Figs. 103 and 104). Unless resection of the wall is complete, recurrence is likely. The wound is closed with drainage.

*Operative Treatment of Varicocele*

Varicocele may be treated by (1) the injection of a sclerosing substance into the tortuous veins or (2) open operation which consists of ligation and excision of the varicose veins with approximation of the cut ends

W. P. D. S. H. 1923

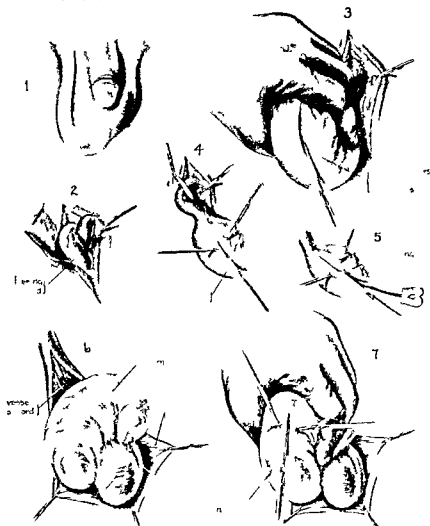
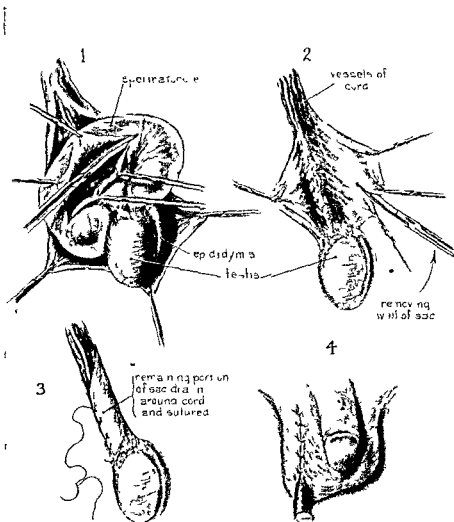


FIG 103 Excision of large spermatocele (1 2) An incision is made in the scrotum and the cord freed. (3 4 5 6) The tunica vaginalis is incised exposing the testis and spermatocele (7) An incision is made in the spermatocele and its contents evacuated

*Subcutaneous ligation of the veins* in varicocele, especially as modified by the elder Keyes in 1886, was used extensively for a great many years, but has now been almost entirely displaced by the relatively simple open procedure



Wm P D duach 1929

FIG 104 Excision of spermatocele (1) Incising the spermatocele (2, 3) The cyst wall is carefully resected except for a small portion, which is sutured about the cord (4) The wound is closed, with drainage

#### THE INJECTION TREATMENT OF VARICOCELE

**Technic.** Sodium morrhuate is the irritant usually employed in the injection treatment of varicocele

The patient stands so that light may come from an angle on the side opposite to that on which the surgeon is working. Local anesthesia should be used, to prevent the patient wincing when the needle is inserted. The surgeon takes a small bunch of veins between the thumb and forefinger and jabs each quickly with a *very sharp* needle. The best site of injection is at or just below the level of the pubis so that the irritant will descend into the torpid veins by gravity.

Following the injection, the patient should rest in the dorsal position for a short time. Later, there will be considerable reaction, but the veins will sclerose quickly, and two or at most three injections will obliterate them entirely.

#### OPEN OPERATION FOR VARICOCELE

**Technic** General anesthesia is sometimes preferable for varicocelectomy, if the patient is neurotic.

An incision is made over the inguinal canal, and dissection carried down to the spermatic cord with its overlying veins. The tortuous veins (usually the spermatic group) are separated from the vas deferens for a distance of about 4 to 6 cm. The veins are transfixed and tied tightly at two points, above and below, and a wedge of veins between the two ligatures is cut away and the two ends tied together, thus elevating the testicle to its proper position. A Penrose drain is inserted into the scrotum, the wound closed, and a suspensory applied.

In resecting the veins of a varicocele, great care must be taken to avoid injury to the internal spermatic artery, which courses in the midst of the pampiniform plexus and to leave a sufficient venous circulation.

**Postoperative Care** Although varicocelectomy is regarded as a minor operation, the patient should be kept in bed for at least 3 days and receive the ordinary postoperative care. A suspensory bandage should be worn for some time, indeed regular support of the scrotum may well be made a routine in one who has suffered from varicocele.

#### *Postoperative Care Following Operations on the Scrotum and Scrotal Contents*

If the operation has been done under spinal anesthesia, the patient's head must be kept lowered for from 6 to 8 hours. The attendant is instructed to observe the scrotum from time to time, to make sure that there is no excessive bleeding, swelling or pain. If such bleeding occurs, the patient must be returned to the operating room and the bleeding points found, clamped, and tied off. Bleeding if allowed to continue

may cause the scrotum to assume enormous proportions, requiring weeks and even months for reduction, due to the peculiar quality of absorption exercised by the areolar tissue

As a rule, there is very little shock in scrotal operations, and the post operative care is usually very simple. When the body wall is opened, the patient must rest in bed for at least 10 days and usually 2 weeks. Daily dressings are done, and the drain is removed as soon as it has accomplished its purpose.

Complications following operations on the scrotal contents are rare. Occasionally, the patient must be returned to the operating room for the ligation of a bleeding vessel. Sometimes, following testicular operations, epididymitis results, which must be treated by suspension of the scrotum and cold or hot applications, according to the desire of the patient. Abscess of the scrotum rarely follows operation in this region, when one occurs, incision and drainage are necessary. Hydrocele may recur, following injection or open operation, and occasionally a secondary hydrocele may form after an operation for varicocele.

The after care in specific conditions has already been noted. In general, every postoperative case of this sort should be seen once a week for a month or two, the patient thereafter reporting any deviation from the normal. The tubercular patient, as has already been emphasized, should be kept under supervision indefinitely. All patients who have been treated for malignancy should be seen every 6 months regularly.

## B NON OPERATIVE TREATMENT OF THE SCROTUM AND SCROTAL CONTENTS

### *Non Operative Treatment of Orchitis and Epididymitis*

Except in cases of abscess, tumor, or tuberculosis palliative treatment of orchitis and epididymitis is the rule. Such patients are immediately put to bed, and in mild cases this will often relieve the patient without further treatment. In all sick rooms the ventilation should be carefully directed. Diet should be bland and proper evacuations of the bowel arranged either by medication or enemas. In cases of extreme pain codeine (0.06 Gm.), or one of the barbituric drugs, is usually sufficient to give the patient relief.

Ordinary cleanliness must be observed. Local application of drugs to the inflamed scrotum is generally practiced, but is of very little use. The commonest drug in use is ichthyol ointment, which is dirty and

foul-smelling and may have a psychological effect, but its efficacy is probably limited largely to that. A suspensory and the intermittent and careful application of an ice-bag usually give great relief. Hyperemia, as produced by an elastic bandage, is frequently helpful. In-

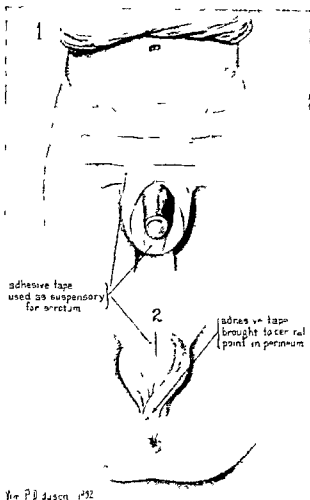


FIG 105 Adhesive tape suspensory for support of the scrotum in inflammatory conditions or following operation.

strumentation should be avoided throughout, if possible, and should under no circumstances be employed during the acute stage.

Treatment with the sulfonamides has proved effective in both acute and chronic infections—both gonorrheal and non-specific.

*Heat* is applied both locally and generally. For the latter, the patient is put into a heat cabinet and kept there for a period of several

hours at a temperature of as much as 107°F. Locally, heat may be applied by means of a sitz bath, the application of a hot water bag directly to the scrotum, or in the form of diathermy. One of the favorite methods of applying heat to the scrotum is by means of the infra red lamp. In general, heat is not so comforting as cold applications.

### *Support of the Testicles and Epididymes*

One of the chief features of treatment of inflammation within the scrotum is elevation of the scrotum. This is accomplished by several methods. The Bellevue suspensory of cloth required so much adjustment that it has been displaced with the adhesive suspensory (Fig 105). This form of support is particularly comfortable for the patient because it elevates the inflamed structures, relieving congestion and holding the scrotum firmly, as if in a splint, and thus has the same comforting effect that a splint has on a broken bone. Such a suspensory, if properly adjusted will help to prevent postoperative complications and make convalescence less tedious.

A modification of the adhesive suspensory was introduced by Dr E Alfred Workman, of the United States Navy Medical Corps. This is open at the top, allowing for expansion. When contraction occurs, with subsidence of the swelling, it may be drawn together at the top so that it fits the shrinking scrotum.

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## CHAPTER XIII

### EMBRYOLOGY, ANATOMY, ANOMALIES, AND PHYSIOLOGY OF THE VAS DEFERENS, SEMINAL VESICLE, AND EJACULATORY DUCT

#### A EMBRYOLOGY

##### 1 *Embryology of the Vas Deferens*

The vas deferens is the excretory duct of the testicle, being a continuation of the epididymis. It originates from the cranial end of the mesonephric (wolffian) duct.

The vas deferens remains comparatively large until about the sixteenth week of fetal life, after which its relative size is considerably less. It descends behind the posterior surface of the bladder in close proximity to the ureter on either side. Lower down, the two vasa gradually approach each other, in the earlier stages of development being contiguous behind the center of the vesical trigone. In the lower part of their course they increase enormously in size so that at the point where they pass beneath the internal sphincter of the bladder they form, with their enveloping tissue, a larger mass than do the terminations of the ureters with their surrounding tissue. At this point the lumen of the vas widens considerably to form the *ampulla of the vas deferens*.

##### 2 *Embryology of the Seminal Vesicle*

The investigations of Lowsley show that the seminal vesicles originate about the thirteenth week of fetal life. In embryos of that age the vesicle appears as an evagination lateralward from the vas deferens, being covered by the same tissue that envelops this structure. The vesicle grows backward and laterally, and at this period consists of a convoluted main duct from which extend numerous short branches which also are convoluted. Not only do branches diverge from the main canal but larger branches give off smaller ones until many diverticula are present in the middle and distal thirds of the vesicle (Watson).

The canal of the vesicle unites with the ampulla of the vas deferens to form the ejaculatory duct. As fetal development proceeds the opening

into the ejaculatory duct becomes comparatively smaller and the component parts of the vesicle larger and more tortuous. At about the twenty-fifth week the vesicles and ampullae have assumed practically their adult form in so far as their general outline and the arrangement of their sacculations are concerned. In a fetus 30 weeks old, the vesicles were found beneath the middle part of the vesicle trigone, communicating with the vasa deferentia deep in the base of the prostate, thus forming the ejaculatory ducts.

At birth, the ends of the vesicles will be found to have extended back almost as far as the base of the trigone. Several branches from the main lumen can be distinguished. The walls of the vesicles, composed of fibrous and muscular strands, are almost as thick as those of the ejaculatory ducts.

### *3 Embryology of the Ejaculatory Duct*

The ejaculatory duct is the termination of the mesonephric duct. It is formed by union of the vas deferens and the seminal vesicle.

Early in fetal life these ducts are of comparatively large size, but gradually become smaller in relation to the surrounding structures. They pass obliquely through the posterior wall of the prostatic urethra, accompanied by the utricle and the surrounding stroma layers, the outer fibers of which attach this cylindrical mass intimately to the urethral wall by intermingling with its tissues.

As these structures approach the lumen of the urethra, its floor is pushed up into a mound and its lumen converted from a triangular to a semilunar shape. This mound—the verumontanum (p. 611)—is made up entirely of the ejaculatory ducts, the utricle, and their surrounding envelops. Below the point where these structures open into the urethra, the verumontanum gradually disappears, the stroma cells becoming intermingled with those forming the urethral wall.

## **B ANATOMY**

### *1 Anatomy of the Vas Deferens*

**Size and Course** The vas deferens, the excretory duct of the testicle is a direct continuation of the epididymis, and extends from the globus minor to the posterior urethra. It is a tough, very muscular, bluish-white tube about 35 to 45 cm. in length and from 2 to 3 mm. in diameter. At its junction with the globus minor it is convoluted, but quickly becomes a straight tube in its ascent through the inguinal canal as one of

the elements of the spermatic cord. It enters the abdominal cavity through the internal ring, traverses the anterior abdominal wall, and then runs extraperitoneally straight to the prostatic urethra.

At first it lies to the outer side of the deep epigastric artery, but farther on it will be found in the extraperitoneal fat, anterior and internal to the external iliac vessels and the obliterated hypogastric artery, thence passing into the pelvis. Taking a downward and backward course, it curves around the side of the bladder (running between the bladder and ureter), loops over the ureter, and reaches the base of the bladder. Thence it passes along the inner side of the corresponding seminal vesicle, between the base of the bladder and the rectum, gradually approaching the vas of the opposite side. Here the vas, together with the seminal vesicle, is enclosed in a sheath derived from the rectovesical fascia.

Just before entering the prostate gland, the vas becomes enlarged and sacculated, forming the *ampulla of the vas deferens*, then, becoming narrowed at the base of the prostate, it joins with the duct of the seminal vesicle to form the common ejaculatory duct, which pierces the prostatic fissure and opens into the prostatic urethra on the verumontanum.

**Structure** The walls of the vas are enormously thick (about 0.7 mm) in comparison with its canal, which is very small (about 0.5 mm). It is lined with a double-layered, ciliated, columnar epithelium partly thrown up into folds. This is covered by a stratum of connective tissue and three well-developed layers of smooth muscle fibers: a thin inner longitudinal, which is present only at the beginning; a thick middle circular, and a thick outer longitudinal. Outside this muscular tunic is a layer of vessels, lymphatics, and nerves supported by fibrous adventitia. The vas is easily distinguished from other elements of the cord by the thickness of its wall and its firm consistency.

*The ampulla*, or dilated, spindle-shaped vesiculoprostatic end of the vas, instead of being a simple tube, is similar in structure to the vesicle and ejaculatory duct. It consists of a tortuous main duct, its walls forming diverticula separated by projecting fibrous folds.

There is some question as to whether the ejaculatory duct is a direct continuation of the duct of the seminal vesicle, with the ampulla of the vas deferens joining it on its mesial aspect, or whether it is a direct continuation of the vas deferens. Extensive investigations indicate that it is a direct continuation of the seminal vesicle duct, and the vas deferens a tributary, joining it on its mesial aspect at various angles ranging from the extreme acute type up to an almost complete right angle (McCarthy, *et al.*)

**Blood Supply and Innervation** The vas deferens receives its blood supply through branches of the deferential artery, deriving from the inferior (sometimes superior) vesical artery.

The innervation of the vas is derived from the inferior hypogastric plexus (*Nerves of the Testicle and Epididymis*, p. 371).

## 2 *Anatomy of the Seminal Vesicle*

**Size, Shape, Location** The seminal vesicles are paired, elongated, sacculated bodies situated in the deep pelvis on either side of the median line, between the base of the bladder and the rectum. They lie along side and external to the vasa deferentia and in close relationship to the ureters, bladder, and prostate. They are beneath the peritoneum embedded in a network of areolar tissue and covered by the fascia of Denonvilliers, which likewise envelops the prostate. The enlarged, convoluted end of the vas deferens (ampulla) rests upon the inner side of its vesicle.

The vesicles have an irregularly lobulated surface, and vary in size and shape, even upon the two sides of the same individual. They average about 5 cm. in length. In shape, they are somewhat piriform, their broad upper ends being directed backward and diverging from each other, and their narrow lower extremities converging toward the base of the prostate, where each vesicle joins with the ampulla of the corresponding vas to form the ejaculatory duct. The normal vesicle is usually widest just below its middle portion.

The vesicles are surrounded by an envelop consisting posteriorly of three layers but having only two layers on the anterior (vesical) side. This three layered fascial "hammock," in which the vesicles lie was first described by Lowry.

**Structure** Each vesicle consists of a convoluted central canal giving off a variable number of lateral branches. The convolutions are held together by fascia. Internally, all the ducts present depressions—diverticula—separated by fibrous ridges. Externally, they are united by connective tissue to form a firm continuous mass with an irregularly lobulated surface.

The main canal, when uncoiled, is about the width of a goose quill and varies in length from 10 to 15 cm. It is closed at its upper end, but its lower extremity becomes constricted into a narrow duct—the *seminal vesicle duct*—which joins with the ampulla of the vas to form the ejaculatory duct. There is great normal variation in the form, capacity, and lumen of the convoluted seminal vesicle tubule, in the number and ar

rangement of the sacculations, and in the position of the ejaculatory duct in relation to the seminal vesicle duct and the ampulla

The wall of the seminal vesicle consists of (1) an internal secreting mucous membrane, the epithelium being of the columnar type and containing yellow pigment, (2) a middle coat of smooth muscle consisting of two layers, an inner circular and an outer longitudinal, and (3) an external layer of fibrous adventitia carrying the vessels, lymphatics and nerves

**Seminal Fluid** The cavity of the seminal vesicle is filled with a grayish white fluid, the bulk of which is secreted by the vesicle, and which also contains the testicular secretion and the spermatozoa. The secretion of the seminal fluid constantly goes on during the period of virility, and it is stored temporarily in the cavity of the seminal vesicle and ampulla

**Blood Vessels\* Lymphatics Nerves** *The arteries* supplying the seminal vesicles are derived from the inferior vesical and the middle hemorrhoidal

*The veins and lymphatics* accompany the arteries. The lymphatics anastomose with those of the bladder and prostate and pass to the external and internal iliac nodes

*The nerves* are derived from the pelvic plexus

### 3 *Anatomy of the Ejaculatory Duct*

**Size and Course** The ejaculatory duct is the common duct of the seminal vesicle and vas deferens. Each ejaculatory duct is formed by the junction of the constricted lower extremity of the seminal vesicle (seminal vesicle duct) with the ampulla of the vas. It is a very narrow canal, about 2 cm. in length

The ejaculatory ducts commence at the base of the prostate and run a parallel course forward and downward through the prostate to open into the posterior urethra by separate slit like orifices on the verumontanum. The ducts converge and also diminish in size toward their terminations. For most of their course they are separated by a thin septum of fibrous and elastic tissue, which is easily penetrated even by soft, flexible instruments. The lumen at the orifice is slit like at the junction of the ampulla and vesicle circular

**Structure** The ejaculatory duct is of the same general structure as the ampulla and seminal vesicle. For most of its course it is lined by a columnar epithelium which becomes more flattened near the orifices

This is covered by a stratum of muscle fibers consisting of an outer, thin, circular layer and an inner longitudinal layer .

### C ANOMALIES OF THE VAS DEFERENS, SEMINAL VESICLE, AND EJACULATORY DUCT

Anomalies of the seminal vesicle and vas deferens are largely dependent upon those of the testicle. In a few instances there has been found unilateral absence of a testicle and seminal vesicle, with part, at least, of the vas deferens. Occasionally there has been absence of the vesicle, vas, and epididymis, but the testicle has been present. Unilateral absence of the vesicle is more common than bilateral absence. Sometimes there may appear to be reduplication of a seminal vesicle but careful dissection is likely to show that it is but an enlargement of one of the natural branches of the vesicle.

Anastomosis of the ampullae has been observed as has also persistence of the mullerian ducts with anastomosis of the ampullae.

Congenital malformations of the ejaculatory duct are mainly abnormalities of termination. Instead of emptying into the posterior urethra, on the verumontanum, one or both ducts may open into the ureter, bladder, or anterior urethra.

### D PHYSIOLOGY

**Function of the Vas Deferens, Seminal Vesicle, and Ejaculatory Duct** The vasa deferentia convey the testicular secretion containing the motile spermatozoa from the epididymes to the seminal vesicles and further develop the motility of the sperm. The peristaltic action and the cilia like appendages of some of its lining cells enable the vas to facilitate greatly the progress of the sperm. The ampullae and seminal vesicles serve as reservoirs for the semen. The vesicles, in addition, secrete a fluid which dilutes the testicular secretion. The vasa vesicles and ejaculatory ducts all participate in the expulsion of the semen into the posterior urethra just before ejaculation.

**The Seminal Fluid** The lining mucosa of the seminal vesicles contains albuminous glands which contribute to the semen a mucoid secretion composed largely of globulins. Since the semen becomes more fluid upon standing, the addition of these globular masses by the seminal vesicles merely serves to increase the volume of the fluid. In some animals this secretion is made to clot through the agency of a ferment derived

from the prostate. A plug is thus formed in the vagina, preventing the escape of sperm.

In their comprehensive biochemical studies of the fluids of the seminal tract apart from spermatozoa, McCarthy and his collaborators found an unusually high concentration of calcium, inorganic phosphorus, hydrolyzable phosphorus and amino nitrogen, with a sugar content of marked variation. Huggins and Johnson, in a study of the seminal tract fluids, found (1) that spermatocele fluid contains no acid soluble phosphorus or glucose, (2) that semen contains large amounts of glucose, calcium, and acid soluble phosphorus, and relatively small amounts of chloride, (3) that the seminal vesicle contains approximately the same amounts of these substances as semen. Therefore, the seminal vesicles must be the chief source of origin in the semen of acid soluble phosphorus and glucose.

The seminal fluid, therefore, consists of testicular secretion into which motile spermatozoa have migrated and the seminal vesicular secretion to this are later added secretions from the prostate, Cowper's glands and the mucous glands of the urethra.

The semen is gelatinous, whitish, albuminous, and alkaline. Its specific gravity is usually about 1.033. It gives off a characteristic odor, which is contributed by the spermin contained in the secretion from the prostate.

**Ejaculation.** The discharge of the semen begins by a powerful peristalsis of the vasa deferentia, seminal vesicles and ejaculatory ducts which forces the secretion into the urethra. Simultaneously the sphincter vesicae contracts, blocking completely the passage of the fluid into the deep urethra. At either side of the verumontanum is a hollow that receives the secretions from Cowper's glands and the prostate, which, with the secretion of the mucous glands of the urethra, are thus mingled with the seminal fluid as it passes through the urethra.

The ischiocavernosus and bulbocavernosus muscles and the sphincter of Henle, with certain other striated muscles of the penis, now begin a series of involuntary rhythmic contractions though the actual act of ejaculation is a voluntary one, controlled by a reflex center situated in the lumbar segment of the spinal cord. Ejaculation is, therefore, a complex coordination of the musculature of the epididymes, vasa deferentia, seminal vesicles, prostate, perineum, and penis.

Among the nerves which influence erection and ejaculation are the nervus pudendus, nervi erigentes and nervus ilio inguinalis. The

nervus pudendus sends one of its branches, the nervus perinei, to the ischiocavernosus, bulbocavernosus, and transverse perineal muscles, and the mucous membrane of the upper urethra. This nerve is, therefore, the one which controls ejaculation.

The mechanism of erection is described under Physiology of the Penis, page 241.

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## CHAPTER XIV

### INJURIES AND DISEASES OF THE VAS DEFERENS, SEMINAL VESICLE, AND EJACULATORY DUCT

#### A INJURIES OF THE VAS DEFERENS, SEMINAL VESICLE, AND EJACULATORY DUCT

Traumatic injuries to the vas deferens are very unusual. When they do occur, it is usually the inguinal portion of the vas that is involved. Occasionally, a crushing blow in this region may cause sufficient injury to necessitate operative intervention. By far the greatest number of injuries to the vas are due to the activities of the surgeon when performing operations for hernia, varicocele, hydrocele, undescended testis, and other lesions in this region.

The seminal vesicles are so deeply situated and so well protected that they are practically immune to injury from external violence. Even in rupture of the base of the bladder, they almost always escape. In the rare cases when the vesicles are injured, there is practically always associated and more severe injuries of other structures.

The ejaculatory ducts are occasionally injured during operations upon the prostate. In the various types of perineal prostatectomy they are carefully protected, but in suprapubic prostatectomy the verumontanum may sometimes be partially or completely torn off, and in this laceration there is destruction of the terminations of the ejaculatory ducts.

#### B DISEASES OF THE VAS DEFERENS, SEMINAL VESICLE, AND EJACULATORY DUCT

##### 1 *Diseases of the Vas Deferens*

###### *Deferentitis*

**Gonorrheal Deferentitis** Ordinarily, in the presence of an acute gonorrheal epididymitis, involvement of the vas deferens will attract little or no attention. Gonorrheal deferentitis can, however, occur without coincident inflammation in either the epididymis or testicle. The focus of infection is usually in the posterior urethra or prostate, whence the infecting organisms reach the epididymis either by way of the lym

phatic ducts or a retrograde peristalsis of the vas deferens itself. While passing through the vas, the gonococci may adhere to the mucous lining, later penetrating the intervening muscular layer and the external areolar covering.

The resulting deferentitis presents the following typical microscopic picture. The epithelial cells of the vas become swollen and partially desquamated, round cell infiltration of the submucosa and muscularis takes place, and acute lymphangitis of the vas deferens arises, evidenced by the polymorphonuclear infiltration of the lymph spaces of the muscularis. The inflammation will usually subside in a short time without going on to abscess formation, but occasionally gonococcic deferentitis has been held responsible for intra abdominal abscess of obscure origin.

**Deferentitis of Non-specific Origin.** Any of the infections which attack the testicle and epididymis is readily transmissible to the structures of the cord. Usually the causal organism is easily identified but occasionally inflammation of the vas deferens is seen for which no cause can be determined. Suggested etiological factors are trauma, a systemic infection, such as influenza, and metastasis from a primary focus in the tonsils, teeth, etc. The symptoms in general, are those of pelvic abscess, but on incision of the inguinal canal the vas and other structures of the cord will be found swollen and bathed in serum, or abscess formation will already have taken place. Drainage is usually followed by an eventful healing, and bacteriological examination may fail to cast any light upon the cause of the infection.

**Diagnosis.** Pain is the predominating symptom of deferentitis. The pain is accompanied by swelling and tenderness to deep palpation. Frequently there is fever, and sometimes nausea and vomiting.

**Differential Diagnosis.** The differential diagnosis may be difficult. Such inflammation may simulate abscess of the abdominal wall, an irreducible inguinal hernia, or, if the swelling is on the right side and rather high up toward the internal inguinal ring, acute appendicitis. An infected neoplasm of the spermatic cord may offer difficulties in differential diagnosis. Confusion with tuberculosis is unlikely, because the tuberculous vas presents alternate nodular and normal areas, giving it a characteristic beaded effect.

**Prognosis.** The prognosis is usually favorable for complete recovery without operation unless the condition has progressed to abscess-formation. A week or 10 days is often required to effect relief of pain, and the swelling may not reduce completely for many weeks.

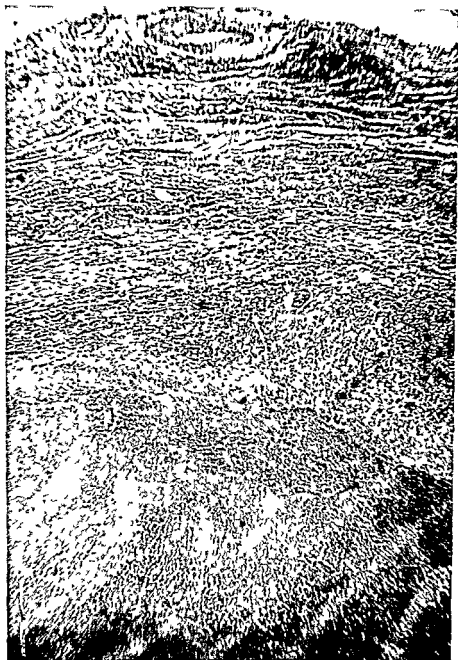


FIG 106 Tuberculosis of vas deferens Photomicrograph The wall of the vas shows some giant cells and much fibrosis. The lumen is filled with caseous material, with some attempt at fibrosis

**Treatment.** Treatment consists of rest in bed, sedatives if the pain is severe, and hot or cold applications to the skin over the cord. Incision and drainage will be necessary if there is abscess formation.

### *Syphilis of the Vas Deferens*

The vas deferens and seminal vesicles are so seldom affected by syphilis that the possibility merits but passing mention. A careful survey of the literature by Thompson, in 1920, disclosed only 13 possible cases of syphilis of the spermatic cord, only 7 of which were regarded as being unquestionably authentic. He found no reports of syphilis of the seminal vesicles.

The chief symptom is enlargement, which may vary from a mere thickening to a tumor the size of a large orange. Obliteration of the vessels of the cord by the fibrous infiltration may occur.

Syphilis may involve the vas deferens at any time during the course of the disease, and its course in the vas apparently differs in no way from a similar process in the testicle.

### *Tuberculosis of the Vas Deferens*

In patients with tuberculous epididymitis and seminal vesiculitis the vas deferens may be unaffected, or it may be involved at one or the other end, or throughout its entire length. The involvement may vary from a slight thickening to nodulation. (Tuberculosis of the Epididymis, p. 440, of the Seminal Vesicle, p. 547.)

### *Stricture of the Vas Deferens*

Occlusion of the vas deferens from stricture is very common. Stricture of the vas may follow trauma or inflammation. It not infrequently follows vasotomy. It usually occurs in the scrotal portion of the duct which is almost always involved in epididymal infections. Bilateral stricture following gonorrheal epididymitis is a common cause of sterility.

The relation of stricture of the vas to sterility, and its treatment, are discussed on pages 475 and 505.

### *Calcification of the Vas Deferens, Ampulla, or Seminal Vesicle*

Calcification of the vas deferens, ampulla, or seminal vesicle is seldom encountered, either clinically or at autopsy. We have seen but one such case, and a careful search of the literature reveals reports of

only 31 others up to 1939. The distribution of the calcification in these 32 cases was as follows

	UNILATERAL	BILATERAL
Vas deferens	5	3
Ampulla	2	8
Seminal vesicle	2	7
Vas deferens and seminal vesicle		2
Ampulla and seminal vesicle		1
Vas deferens and ampulla		2

**Etiology.** There are two types of calcification: (1) non-inflammatory and (2) inflammatory.

Non-inflammatory calcification occurs in elderly men, and is probably due to senile changes of the muscularis. Chiari describes this type as "a pure regressive metamorphosis of the tunica muscularis without any pathologic change in the mucosa and without any inflammatory process of the vas deferens or seminal vesicle." The inflammatory form of calcification of the vas deferens or seminal vesicle follows a chronic inflammatory infection, such as tuberculosis or a protracted specific or non specific chronic deferentitis or seminal vesiculitis.

**Symptoms and Diagnosis.** Calcification may occur at any age, although most of the patients are over 50 years old. The ages in the reported cases varied from 14 to 81 years. Four patients were under 30 years, 9 were between 30 and 50 years, 5 between 50 and 60 years, and 12 between 60 and 81 years. In 7 cases the age was not given. The youngest 6 all had some tuberculous manifestation, and calcification in a young man should always suggest genital tuberculosis.

There may be a history of pain, spermatic colic, hematuria, or other symptoms which are in no way pathognomonic. Usually the condition is discovered on rectal palpation or roentgenographic examination for some other condition, or at operation or autopsy. Twenty-one of the 32 cases mentioned above were found at autopsy, 1 at operation (prostatectomy), and 10, including our own, were diagnosed clinically.

Calcification of the vas deferens, ampulla, or seminal vesicle is diagnosed by rectal palpation and roentgenography, and confirmed by vasography or seminal vesiculography. Palpation of a stony hard mass may lead one to suspect malignancy of this area, and the two conditions must be differentiated. Shadows in the plain roentgenogram must be

differentiated from those caused by phleboliths and stones in the ureter or bladder

In our own case the patient who was 67 years of age complained of pain in his back nocturia burning and some dysuria Examination disclosed an enlarged stony hard prostate The urine contained considerable albumin and many white and red blood cells Roentgenographic examination which included excretory urograms and an aerogram cysto urethrogram and cystogram showed calcified ampullae of the vasa deferentia bilateral hydronephrosis bilateral hydro ureters



FIG 10 Authors case of bilateral calcification of the ampullae of the vasa deferentia in a 67 year-old man Flat plate showing the calcified ampullae and enlarged prostate

chronic upper urinary tract infection lower urinary tract obstruction and an enlarged prostate A biopsy specimen removed from the prostate showed carcinoma Roentgenography following the injection of an opaque medium into both vasa was subsequently done to determine if the two calcified bodies were vasa deferentia or calcified vessels this proved them to be calcified ampullae of the vasa A transurethral resection of the prostate gland was done

**Treatment** Treatment is seldom indicated In the older group of men where the calcification is due to senile changes there are usually

no symptoms referable to the calcified vas or vesicle. In the younger men the calcification is almost always part of a tuberculous process of the urogenital tract (Tuberculosis of the Seminal Vesicle, p. 547, Tuberculosis of the Epididymis, p. 440)

## 2 Diseases of the Seminal Vesicle

### *Seminal Vesiculitis*

Seminal vesiculitis is of clinical importance in three forms (1) gonorrheal, (2) tuberculous and (3) non specific

In many cases of acute gonorrheal inflammation the seminal vesicles and ejaculatory ducts escape involvement. Even in cases in which there is acute prostatitis and epididymitis the vesicles often present no clinical evidence of participation in the infective process. In chronic gonorrhea, however, infection of the vesicles in association with the prostate is common.

Any pathogenic organism may cause seminal vesiculitis. Mixed infections are frequent. A non specific infection superimposed upon a neisserian infection will often account for the disappearance of the gonococcus from the vesicular secretion, only to give rise to more serious, but non specific, complications.

Like the prostate, the seminal vesicles have acquired considerable clinical importance in recent years as foci of focal infection. The structure of the vesicle, with its diverticula and mucosal folds, and insufficient drainage, favors chronicity once bacteria have gained entrance, and makes of them ideal foci of infection.

**Etiology** Congenital anomalies, such as persistence of the mullerian ducts and abnormally wide or strictured ejaculatory ducts, seem to predispose to the development of seminal vesiculitis. Prolonged congestion or distention of the vesicles due to continued sexual excess or abstinence facilitates the development of vesiculitis in the presence of a gonococcal infection or some remote focal process. Elimination of the primary focus rarely clears up the vesiculitis; on the contrary, the vesicles are often responsible for the continuance of focal manifestations originally caused by the primary focus.

Seminal vesiculitis almost always occurs as part of a general infection of the genital tract, the posterior urethra being the most frequent source. Too early instrumentation in acute or subacute gonorrhea will often result in involvement of the vesicles.

Infection may reach the vesicles (1) by extension from the posterior

urethra, either by continuity of the mucosal surface or by lymphatic invasion, there being free communication between the lymphatics of the vesicles, prostate, urethra, and bladder, (2) from above (epididymes) through the genital tract, (3) by the blood stream, from distant foci of infection such as diseased teeth, tonsils, and sinuses. The most frequent route of invasion in both the gonorrheal and non specific forms is undoubtedly by *direct surface extension through the ejaculatory ducts*. Infectious material ascends the ejaculatory ducts from a posterior urethritis or prostatitis, inflammation produces more or less edematous or infiltrative obstruction of the ducts, or they may be blocked by detritus and mucous plugs, and bacteria and stasis in the vesicle complete the pathological process.

Involvement of the vesicles is practically always bilateral, and the ampullae and ejaculatory ducts almost invariably participate in the pathological process. While chronic inflammation of the ejaculatory ducts may occur without seminal vesiculitis, no marked vesiculitis is ever seen without a corresponding inflammation of the ejaculatory ducts. There is almost always some associated prostatitis.

**Organisms** Any pathogenic organism may set up a seminal vesiculitis. In cultures of 38 specimens of seminal secretion obtained through a sterile endoscopic tube Delzell and Lowslev found, in addition to the gonococcus 4 varieties of staphylococcus (albus 10, aureus, 9, viridans, 2, hemolyticus, 2), 2 varieties of streptococcus (viridans, 10 hemolyticus, 3), *Bacillus coli communis*, 4, *Micrococcus tetragenus*, 2, *Bacillus pyocyaneus*, 2, *Bacillus proteus*, 1, and diphtheroid bacillus, 1. White and Gradwohl cultured the gonococcus in 80 per cent of their 1,000 cases of seminal vesiculitis, 60 per cent being pure cultures and 40 per cent mixed infections. The stage of the vesiculitis at which the cultures are taken may be important, as clinical experience shows that secondary infections predominate sooner or later, usurping the place of the gonococcus. The tubercle bacillus causes a distinct type of seminal vesiculitis.

Non specific organisms predominate in the chronic forms of seminal vesiculitis, even in the primarily gonococcal. Infections caused by staphylococci, streptococci, and *Bacillus coli communis* are probably more common than is generally realized.

**Pathology** The pathology of the seminal vesicles and ejaculatory ducts until recently has failed to receive the study it deserves, and the precise status of the vesicles as a factor in disease remains to be de-



terminated There is no doubt, however, that they are common foci of infection

The minute anatomical structure of the seminal vesicles is an important element in the production of chronicity and in determining the type of tissue reaction to invading bacteria In general, the pathology of seminal vesiculitis is similar to that of inflammation arising in other structures having a cavity lined with mucous membrane The acute stage begins with engorgement of the vessels, and may go on to suppuration and abscess formation if the process fails to resolve and subside or to become chronic The subacute stage is marked by round cell infiltration of the wall The chronic stage shows an increase of hyaline and connective tissue stroma, which may greatly thicken the wall and diminish the lumen This condition is invariably associated with perivesicular fibrosis with the formation of adhesions to the surrounding structures The infiltration and fibrosis may even produce constriction of the vesical neck or obstruction of the lower ends of the ureters, resulting in hydronephrosis

Cunningham, Delzell and Lowsley, and others have pointed out that operative specimens of seminal vesicles often fail to show pathological changes to account for the symptoms that were observed clinically The presence of microorganisms in the vesicles without histological evidence of an inflammatory process suggests a bacterial infestation rather than an infection This would explain the severity of toxic manifestations in cases which, histologically, showed only slightly affected vesicles

*Pathological Changes in the Verumontanum* The urethroscopically observed changes in seminal vesiculitis are seen mainly on the verumontanum, although these cannot be regarded as pathognomonic The verumontanum may be normal in size and color but be granular, or it may be small very firm and of a pearly white tint, or greatly enlarged and congested with its surface dotted with red and white spots In the last type the slightest manipulation induces bleeding and the ejaculatory ducts may be invisible because of the hypertrophy Often however there will be a small area of congestion around the duct orifices by which they may easily be located When the verumontanum is of the small, sclerotic type, the ducts can usually be made out, the openings sometimes being wide and gaping probably being rendered rigid by the infiltration of the walls Pus exuding from the orifices of the ducts is pathognomonic of seminal vesiculitis

**Signs and Symptoms** *Acute seminal vesiculitis* usually begins with

chills, fever, and general malaise. There may or may not be urinary disturbances, such as frequency and dysuria. Pain may be severe, and referred to the suprapubic and inguinal regions, or to the hip, thigh, and back of the affected side, or to the region of the kidney. It may even simulate ureteral colic, appendicitis, or cholecystitis. Acute seminal vesiculitis may be accompanied by widespread dissemination of the gonococci or other organisms, causing bacteriemia, rheumatic fever, polyarthritis, or other infective complications. On the other hand, the onset of an acute vesiculitis may be relatively mild.

The symptoms of *chronic vesiculitis* are varied and complex. Some patients have few symptoms, in others, they are many and varied. Pain is common. It frequently takes the form of a heavy feeling or a pronounced ache in the perineum, or it may center around the hip, thigh, and back of the affected side. Most patients have one or more signs of a genito urinary disturbance, such as frequency and urgency, dysuria, precocious ejaculation, frequent involuntary seminal emissions, and functional impotence. Complaints are frequently made of paresthesia of the genital and surrounding regions, including cold or clammy sensations, burning, itching, or formication, and of painful ejaculation and pain following coitus, accompanied by deep inguinal or perineal discomfort.

Objective symptoms include abnormal sensitivity on digital examination, enlargement and infiltration of the prostate and seminal vesicles, thickening of the vasa and distention or infiltration of the epididymes, pus and blood in the voided urine and in the prostatic and vesicular secretions, necrostermia, azoospermia, oligospermia, and complete lack of seminal fluid.

Attempts have been made by many investigators to classify the various clinical forms of seminal vesiculitis. Andrew P. Peterson, of the Brady Foundation, in the New York Hospital, has suggested the following clinical grouping:

- A. Catarrhal
  - 1 Early stage
  - 2 Intermediate stage
  - 3 Late stage
- B. Interstitial
  - 1 Early stage
  - 2 Intermediate stage
  - 3 Late stage
- C. Mixed

The clinically *normal* gland (Fig. 108) is small, soft, ovoid or elongated, palpable or impalpable, tender, and free of adhesions. It drains freely but moderately, both on ejaculation and massage. Depending on findings in the seminal secretion, it may be normal or the site of incipient, non-virulent infection or infestation.

The various clinical forms of seminal vesiculitis are shown in figure 109.

Distinction must be made between the *physiologically distended* vesicle, which is common in cases of prolonged sexual abstinence, and the vesicle in which there is an *early catarrhal* seminal vesiculitis. The distended vesicle is ovoid, medium to large, soft to firm, easily palpable, and usually



FIG. 108 Retrograde seminal vesiculogram of normal seminal vesicle. The clinically normal vesicle is ovoid or piriform in outline, and widest in its proximal portion. It shows from 10 to 12 close-lying convolutions of uniform breadth and density. The ampulla is distinctly separated from the vesicle. The vas takes its lateral course high above the terminal pole.

tender. It drains freely and profusely, both on ejaculation and stripping. The possibility of a low-grade infection or infestation being harbored in such a vesicle should be thoroughly investigated.

In the *intermediate catarrhal* stage the dilated vesicle is piriform, firm, easily palpated, and usually very tender. Secretion is sometimes difficult to obtain, due to edema of the ejaculatory duct and extreme sensitiveness to massage. Ejaculation and stripping may be accompanied by pain and hemospermia.

In the *late catarrhal* stage (pyovesiculosis) the sacculated vesicle resembles a tortuous hydro-ureter in shape and consistency. It is easily palpated, though seldom in its entire length, and usually tender.

Adhesions are common. Active drainage is reduced or absent, passive drainage may produce copious purulent or mucopurulent secretion. This type of vesicle is the end product of long standing maximal dilatation with loss of elasticity and contractibility.

The *early interstitial* vesicle is irregularly ovoid, small to medium in size, thickened, easily palpable, and usually not sensitive. Drainage is seldom impaired, but the secretion is reduced. The *intermediate interstitial* stage is characterized by an elongated, thickened, narrow, tubular vesicle that is palpable and not markedly sensitive. Drainage is usually impaired and the secretion much reduced. In the *late interstitial* stage the vesicle is nodular or cord like, easily palpable, and usually indolent, with secretion minimal or absent. This type is the end product of long standing inflammation with fibrosis and advanced obstructive changes.

The *mixed forms* are the result of secondary catarrhal infection of an interstitially diseased gland. The vesicles are irregular in shape, size and consistency, easily palpable, very tender, with impeded and reduced drainage.

The catarrhal types more frequently follow non virulent infections—specific or non specific, the interstitial types are most commonly observed in cases of hyperacute inflammation, usually gonorrheal, and in sudden mechanical closure of the ejaculatory ducts, such as may be occasioned by vesical neck resection.

**Diagnosis** The diagnosis of seminal vesiculitis is based on the history, physical examination, urethroscopic inspection, and the laboratory findings. Actual proof of disease, and its location, can be secured by vesiculography.

**The History** The history usually gives presumptive evidence of acute or long standing infection of the seminal tract. Not infrequently however, the history is wholly negative in regard to symptoms referable to the genito-urinary tract. The arthritic patient with no urogenital symptoms and no history of gonorrhea, is a common example.

A large percentage of patients give a history of gonorrhea. Other foci of infection, such as tonsils, teeth, and sinuses should be noted in particular.

**Physical Examination** A properly conducted examination usually establishes the diagnosis of seminal vesiculitis without difficulty, and determines the clinical group in which the case belongs, and whether or not further examination is necessary. Such an investigation should

include (1) thorough examination of the epididymes, vasa, vesicles, and prostate, (2) examination of the urine, (3) microscopic examination of the prostatic and vesicular secretions and the ejaculate

In practically all cases of vesiculitis a consideration of the whole genital tract is required. The external genitals are first examined, particularly the meatus (for irritation and discharge), and the epididymes and vasa. Infiltration of the epididymes or vasa should be viewed with suspicion as suggestive of vesicular involvement. Signs of prostatic disease, especially an infiltration of the upper (subvesicle) margin, call for a careful palpation of the vesicles, as such infiltration invariably compresses the ejaculatory ducts, thereby impeding or suspending drainage. Thickening of an undistended vesicle, with an increased white cell count in the seminal secretion, is a sign of infection. Infiltration of a vesicle, regardless of its size, should be considered definite clinical proof of seminal vesiculitis.

Proper palpation through the rectum (Rectal Palpation, p. 15) is most important. In acute conditions, palpation of a hot, distended, tender, tense, or pulsating vesicle above a swollen prostate is sufficient, with symptoms, to make a diagnosis. In chronic vesiculitis, digital rectal diagnosis is sometimes difficult because the gross changes in the vesicle are often not commensurate with the symptoms. The microscope must therefore be relied upon. Palpation in an acute case must be very gentle, and massage and stripping, as well as instrumentation, are contraindicated until the acute condition has subsided under treatment.

The examiner should note whether the vesicles are swollen and boggy, small, thickened, nodular, or calcified, and whether they empty on stripping. Vesicular massage, productive of little or no secretion, should raise the question of impaired secretion or drainage from one or both vesicles.

*Examination of Vesicular and Prostatic Secretions and Urine.* Comparative analysis of the voided and catheterized urine and microscopic examination of the prostatic secretion, vesicular secretion (left and right), and the ejaculate are essential. The secretions obtained by stripping should be examined for pus, red blood cells, bacteria, and the condition of the spermatozoa, and a specimen should be cultivated for bacterial differentiation and possibly, for autogenous vaccine preparation. We prefer to gather the specimen through a sterile endoscopic tube, and believe that this method more nearly avoids contamination from the anterior urethra, with its extensive flora of bacteria, than other methods.





FIG 109 Clinical types of seminal vesiculitis (1) Early catarrhal vesiculitis Such glands with purulent or mucopurulent contents, give good diffusion and shadows are rich in detail Distention causes the upper margin to be raised close to or above the ampulla reducing or filling the vesico-ampullar space Convolutions still preserved (2) Intermediate catarrhal vesiculitis There is definite dilatation of the distal half The terminal portion is raised to or above the level of the vas (3) Late catarrhal vesiculitis Dilatation of the entire gland and straightening of the convolutions causes the organ to resemble a tortuous hydro ureter (a) or a v of circular or oval cavities—pyovesciculosis (b) Engorgement of the vesicle brings its terminal pole high above the level of the vas and close to the ureter (4) Early interstitial vesiculitis Shows a few circular or spiral convolutions There is localized distention and beginning obliteration of lumina (5) Intermediate stage This type presents elongated and narrow tubular shadows with shallow wavy convolutions Diverticula are usually absent Such glands are readily injected with viscous dyes without losing their shape and structure and are therefore often considered normal (6) Late interstitial vesiculitis Vesiculograms at this stage show a few irregular cavities which may appear to be completely detached (7) Mixed type Partial dilatation of a typically interstitial gland is evident The structure or angulation of the ejaculatory or seminal duct causing the retention is usually demonstrable

used The separate secretions from the three glands may also be recovered from the bladder contents, voided immediately after massage and stripping (*Microscopic Examination of Prostatic and Vesicular Secretions*, p 18)

The diagnosis must often rest on the microscopic examination of the expressed secretions A negative finding on one or two examinations is insufficient proof that infection is not present The infected area in the vesicle or prostate may be closed off, and several manipulations or dilatation of an ejaculatory duct, may be necessary to establish drainage from a vesicle Not until there have been three normal secretions on successive examinations several days apart should a case be pronounced negative

*Observation Urethroscopy* Routine examination, as described above, will indicate whether or not urethroscopic inspection is required

By using a cystoscope holder, which contributes considerably to the ease of instrumentation and the comfort of the patient, urethroscopies including catheterizations of the ejaculatory ducts and vesiculographies may often be done without the use of an anesthetic If preferred however, the urethra may be rendered insensitive by means of a local anesthetic (p 100)

The patient is prepared as for any urethral examination and the meatus first examined Should it prove too small for the passage of the urethroscope, meatotomy will have to be performed

At urethroscopy, the condition of the posterior urethra is noted The urethroscopically observed changes in seminal vesiculitis are seen mainly on the verumontanum Edema or granulations should be treated with topical applications of phenol glycerine—this escherotic being preferable to nitrate of silver as it does not leave an irritating metallic precipitate on the mucous membrane In a properly dilated posterior urethra a few applications will clear the verumontanum and its vicinity sufficiently to permit detailed observation, good orientation, and catheterization of the ejaculatory ducts without bleeding or inflammatory reaction *Although the position of these orifices varies considerably in different individuals they are usually found high up on the lateral walls of the verumontanum, slightly outward from the opening of the utricle Once these orifices are located, it is relatively easy to catheterize the ducts with a specially devised instrument*

However, if the verumontanum is swollen and granular, the ducts



may be invisible. It may then be necessary to probe gently in the region where the orifices normally are located until the instrument can be made to pass. Occasionally, all that can be done at the first session will be to cauterize the swollen verumontanum, the examination of the ducts being postponed until the swelling and granulations have cleared up.

*Vesiculography* Radiography following the injection of an opaque medium into the ejaculatory ducts (Seminal Vesiculography, p. 185) will reveal abscesses or other abnormalities of the seminal vesicles, as well as stricture and other pathological and anomalous conditions of the vasa deferentia and the ejaculatory ducts. It is possible, by vesiculograms, to differentiate two sharply defined clinical types of vesiculitis—the catarrhal and the interstitial (Fig. 109).

*Differential Diagnosis* A careful history and examination will usually bring out the essential points in determining the diagnosis of seminal vesiculitis. Acute gonorrheal involvement is readily recognized by the presence of the disease in the urethra and the feel of the vesicle which rapidly changes from a characteristic boggy in the early stages to tenseness and rigidity as the swelling progresses. Gonococci and pus are usually present in the vesicular secretion. In chronic infections the gonococci may be absent in the secretions, or other organisms may be present. In chronic infections both specific and non specific the vesicles are generally enlarged and more or less indurated. In the indurated stage they may be confused with tuberculosis. The latter, however, shows a greater tendency to nodulation than the fibrous non tuberculous vesicle.

Malignancy may also be difficult to distinguish on palpation alone. The induration is of a stony hardness and increases rapidly in size. Correct diagnosis is facilitated by removing a piece of tissue for examination by means of a biopsy instrument such as the Lowsley biopsy punch.

Calculus and calcification may be confused with tuberculosis or, rarely, with the late interstitial stage of vesiculitis, due to the presence of hard nodules. Roentgenography is usually helpful in making the diagnosis.

*Prognosis* A large percentage of acute cases respond to palliative measures. Some scarring results in every case, and the patient should have proper treatment of the seminal vesicles following subsidence of the acute and subacute symptoms. Exceptionally, suppuration or abscess may necessitate surgical drainage or resection. It is our opinion

that since so many patients are entirely relieved of symptoms by palliative treatment, all cases of seminal vesiculitis, except those with abscess formation, should have the benefit of palliative treatment before being subjected to operative procedures

**Treatment Acute Vesiculitis** Treatment of acute vesiculitis is almost always palliative rest in bed, sedatives, heat to the perineum, hot sitz baths, hot rectal douches every 8 hours, and alkalization of the urine and forced fluids if urinary disturbances are present. Occasionally suppuration may require surgical drainage or vesiculectomy (pp 560 and 561)

The sulfonamide drugs have proved very efficient in these, as in other genito-urinary, infections (see p 1162). Methenamine and an acidifying agent are often useful when the sulfonamides fail or cannot be taken.

**Chronic Vesiculitis** Treatment of chronic infections is *systemic* and *local*. Systemic treatment consists in rest, regulation of the diet so as to avoid alcohol, spices, and other irritating substances, instructions regarding personal and sex hygiene, and avoidance of constipation, which may cause congestion of all the pelvic organs. A dry, equable climate is often of great assistance in the treatment of these cases, particularly if there is an accompanying arthritis or myositis, as there frequently is.

Medicine, administered internally, consists principally of sedatives for the relief of pain (in general, the barbituric acid group are preferable to the coal tar products) and sulfonamide therapy, in an attempt to eradicate the infection.

Vaccine therapy and bacteriophage (p 567) have many advocates.

Local treatment consists of massage or stripping of the vesicle (p 564), urethral dilatations, catheterization of the ejaculatory ducts either for dilatation and improved drainage or for lavage of the vesicles with antiseptics (p 563), and surgical measures (p 560). Resort to surgery is regarded as a radical procedure to be used only after all other methods have failed, except in cases of suppuration and abscess formation, when early drainage is indicated.

*The securing of good drainage is of paramount importance.* Further help is often obtained by the use of antiseptics in combating the invading organism, but good drainage must be established before help from antiseptics can be anticipated. Many surgeons recommend the injection of medication through the vas deferens, a procedure popularized by Belfield and his followers. We prefer, however, the more conservative

procedure of injecting the vesicles through the ejaculatory ducts, and recommend it for all cases of chronic relapsing gonorrheal or non specific infection in which there is evidence of thickened, obstructed vesicles and the usual methods have failed to give relief, as well as for chronic arthritis with chronic relapsing epididymitis. Catheterization of the ejaculatory ducts has been proved an entirely feasible procedure in competent hands. Cases treated in this way have the benefit of the antiseptic plus improved drainage due to the dilatation of the ejaculatory ducts.

Preparatory treatment, consisting of a thorough dilatation of the entire urethra and massage of the prostate and seminal vesicles, should precede catheterization of the ducts. The dilatation should be gradual and free of traumatism. Sessions of dilatation alternate with massage of the prostate and vesicles, the bladder being filled before each procedure with a mild disinfectant, such as acriflavine or rivanol dextrose, 1:5,000.

The vesicles should not be massaged or stripped too vigorously in an attempt to drain the greatest possible amount of secretion on any one occasion. Rather, the chief aim should be gradually to remove adhesions and create some hyperemia, to facilitate resorption. Should the vesicles fail to resume drainage by the time the urethra has been dilated to its maximal capacity, observation endoscopy is indicated.

### *Syphilis of the Seminal Vesicle*

Syphilis of the seminal vesicle is almost unknown, or, at least, it is seldom recognized either clinically or at autopsy. It is well to remember, however, that syphilis can simulate almost any disease. There is no reason why the seminal vesicle should be exempt from attacks by the spirochete, and undoubtedly, if the vesicles of all syphilitics who come to autopsy were carefully examined, evidence of involvement would sometimes be found.

### *Tuberculosis of the Seminal Vesicle*

**Etiology** The controversial question regarding the original focus of the disease in tuberculosis of the genital tract has been discussed under Tuberculosis of the Testicle and Epididymis (p. 440). We are inclined to believe that the epididymis is the focus from which the vesicle is involved in the majority of cases of genital tuberculosis, and that less frequently the seminal vesicle or prostate is the primary focus in the genital tract.

**Pathology.** The pathological changes in the vesicle vary from the usual picture of clustered tubercles to extensive fibrous replacement or complete destruction of the vesicle. Suppuration may be considerable.

When the vesicle is the primary focus, extension of the disease to the ampulla and up the vas to the epididymis is common. The prostate is also likely to be involved by extension down the ejaculatory duct.

**Diagnosis.** Diagnosis is based chiefly upon (1) rectal palpation, which, in most cases, will reveal induration and nodulation, and (2) microscopic examination of the expressed secretions, which may or may not contain tubercle bacilli. Occasionally, differentiation from calcification or calculus of the vesicle, or from the later interstitial stages of seminal vesiculitis, may present difficulties.

**Prognosis.** Tuberculous seminal vesiculitis does not respond well to palliative measures, although the disease may be arrested here, as elsewhere. Following vesiculectomy for tuberculous vesicles the usual care for postoperative tuberculous patients is administered, and is, on the whole, quite satisfactory.

**Treatment.** Operative removal of the diseased vesicles is not attempted until the patient has been subjected to a long period of palliative treatment. If this fails to arrest the disease, seminal vesiculectomy (p. 561) is performed, followed by heliotherapy and the other therapeutic, hygienic, and dietary measures advocated for postoperative tuberculous patients (Treatment of Inoperable and Postoperative Genito-Urinary Tuberculosis, p. 1196). The radical operation—that is, removal of the vesicle, vas, and epididymis on the affected side—is indicated in suitable cases of extensive involvement of the genital tract. For a description of this, as well as a more detailed discussion of genital tuberculosis in general, the reader is referred to the section on Tuberculosis of the Testicle and Epididymis.

### *Abscess of the Seminal Vesicle*

**Etiology.** While infection and suppuration of the seminal vesicles is of common occurrence, actual abscess-formation is rare. It may follow gonorrheal infection, tuberculosis, or non specific infections due to the colon bacillus, various staphylococci, *Streptococcus hemolyticus*, *Bacillus pyocyaneus*, etc. Prolonged congestion due to long-continued sexual excess in the presence of infection may lead to abscess-formation.

**Pathology.** A few cases of bilateral abscess of the seminal vesicles have been reported, but as a rule the condition is unilateral.

Seminal vesicular abscess follows acute vesiculitis. First there is an early catarrhal vesiculitis. The vesicle is enlarged, soft, and drains freely on pressure. This is followed by an intermediate catarrhal condition, in which the vesicle continues to enlarge and drains poorly upon ejaculation or massage. The expelled secretion contains much pus and may be blood stained. If untreated or inadequately treated, abscess formation may follow this stage. The vesicle is greatly enlarged, tender, and hot. As a rule the ejaculatory duct is closed by a pus clot or by inflammatory swelling, so that no fluid is expressed. If secretion is obtained, it will be mucopurulent, often showing red blood cells.

A seminal vesicular abscess may rupture into the perivesicular or perirectal cellular tissue, or the pus may burrow into Douglas's fold of the peritoneum, the bladder, or even into the lumen of the rectum.

When abscess occurs as an accompaniment of tuberculosis the bead like vesicle usually seen in tuberculosis is replaced, partly or wholly, by an abscess cavity.

**Symptoms.** Abscess of the seminal vesicle usually is accompanied by chills, fever, headache, and other symptoms of general toxicity. Frequency and dysuria are common. Pain is present and usually severe. It may be referred to the small of the back, suprapubic region, hips, down the inside of the thighs or along the course of the ureter on the side corresponding to the affected vesicle. There is great pain on digital examination, and the vesicle will be found markedly enlarged and hot. Fluctuation is frequently detectable. Pus and blood are often present in the urine.

It is possible for a huge abscess to be present in a seminal vesicle in the complete absence of fever and symptoms pointing to the vesicular region.

**Diagnosis.** A history of preexisting infection is suggestive. If there is no history of infection and no symptoms pointing to the genito urinary tract, a history of arthritis should lead one to suspect the seminal vesicles, if the teeth, tonsils, and sinuses are negative.

If abscess of the vesicle is suspected, massage and stripping are contraindicated.

Cautious rectal examination will usually disclose the true state of affairs without exerting undue pressure upon the pus collection. A vesicle that is large, hot, tender, and fluctuating leaves no doubt as to the diagnosis. In some cases, however, the vesicle is large, not tender, and surrounded by such an area of edema that there is doubt regarding the presence of an abscess.

Seminal vesiculography is diagnostically helpful

**Treatment and Prognosis** If the abscess is small, palliative measures may be successful in causing absorption. These include rest, sedatives, heat to the perineum, hot rectal douches or hot sitz baths, and alkalinization of the urine. Sulfonamide therapy is useful in some cases. Drainage is aided by gently dilating the ejaculatory ducts with the bougies through the urethroscope.

Large abscesses demand surgical treatment. This is accomplished by a perineal approach. After exposure, the seminal vesicle may be removed or incised and drained, depending upon the condition found by the surgeon. Usually excision is preferable.

### *Tumors of the Seminal Vesicle*

Primary tumors of the seminal vesicle, both benign and malignant, are so rare as to be of little clinical importance.

**Incidence** Carcinoma is the most frequent neoplasm. Modern text books do little more than mention the possibility of the occurrence of primary carcinoma of the seminal vesicle, and fewer than 20 cases have been reported in medical literature. Thomson Walker, in the latest edition of his text book, accepts only 2 or 3 of these as primary in the vesicles.

The earliest record of such a neoplasm appears to be the carcinoma reported by Paul Berger in 1871. Zahn, in 1885, reported a primary sarcoma of the seminal vesicle, with metastases to the heart and other organs. This is the only neoplasm of the seminal vesicle mentioned by Ewing in the 1922 edition of his *Neoplastic Diseases*, and is the only sarcoma cited by Voelcker in his elaborate monograph on the surgery of the vesicles. We have found no additional reports. Voelcker also collected 4 cases of primary carcinoma and reported a case of benign myoma and cited a similar growth seen by Lucksch in 1903. Ceelen reported a case of fibromyoma in 1912. Other cases of carcinoma have been reported by Teubert (1903), Brack (1921), Lyons (1925), Pelagatti (1934), and Trachsler (1934).

McNally and Cochems, in a very complete review of the literature in 1936, found 16 cases of reported primary carcinoma of the seminal vesicles, including one of their own. Of these, only 4 were definitely proved. In their own case the prostate was free of disease and the diagnosis of primary carcinoma of the seminal vesicle was confirmed following radical

excision, done in 1934. The patient was alive and free from metastases or recurrence 2 years later. Included in McNally and Cochem's list of cases, and not mentioned above, are one each reported by Labbé (in Guelhot's monograph), 1882, Walter (1891), Kaufman Burkhardt (1904), Thevenot, Kudlich (1926), and 2 cases reported by Junghanns as having been seen at the institute of Pathological Anatomy of the Stadtkrankenhaus at Dresden between 1893 and 1927.

One case of primary carcinoma of the seminal vesicle, in a man of 60 years, has come under our personal observation (Delzell and Lowsley, 1924). This was a case of Dr. Harold Johnson, seen at the New York Hospital. A growth as large as a lime occupied the right seminal vesicle, and the bladder on the same side was covered with bullous edema. Biopsy proved the growth to be a carcinoma, and at autopsy it was shown to be primary to the seminal vesicle.

Apparently, then, so far as our examination of the literature goes, and accepting all the reports as valid, there is a total of only 3 benign and 18 malignant primary neoplasms of the seminal vesicles. The latter include 1 sarcoma and 17 carcinomas. In many of the published reports, however, there is some doubt as to whether the carcinoma was primary in the vesicle or whether the vesicle was secondarily involved from the adjacent prostate.

**Symptoms and Diagnosis.** In most cases the diagnosis is not made early enough for a hopeful outcome. The condition being discovered late it is often difficult to determine accurately the point of origin. In most of the reported cases metastases were already present by the time the patient came under observation.

Pelagatti's patient was only 30 years old, but the majority were well beyond their fiftieth year.

The most common symptoms appear to be hematuria, deep seated pelvic pain, and more or less interference with urination. The diagnosis is based on rectal palpation of a large, hard, nodular mass in the region of the seminal vesicle. Accurate diagnosis may be facilitated by removing a piece of tissue for examination with the Lowsley or other biopsy instrument.

**Prognosis.** The prognosis of malignant tumors of the seminal vesicles is unfavorable.

**Treatment.** Radical excision, followed by deep roentgen therapy is preferable if the diagnosis is made early enough. Usually, however, involvement is too extensive for other than palliative treatment. radium

and deep roentgen therapy with, possibly, deviation of the urinary stream (Radium and Roentgen Ray Therapy of the Genito Urinary Tract, p 1739)

*Calculi and Calcification of the Seminal Vesicle*

**Calculi** Calculi are seldom found in the seminal vesicles and more rarely still in the ejaculatory ducts or vasa deferentia. Usually they are small and occur in persons past 40 years of age. Obstruction of the

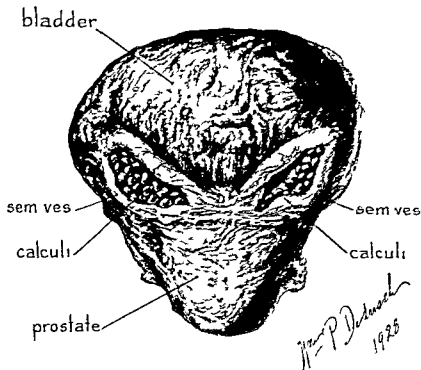


FIG 110 Calculi in both seminal vesicles. Posterior view of the bladder and seminal vesicles, showing multiple stones in both glands. (Chris-eller)

ejaculatory ducts with stagnation of the seminal fluid and metabolic disturbances have been suggested as etiological factors in their formation. We have seen one case of bilateral multiple calculi of the seminal vesicles, which was discovered at autopsy.

**Calcification.** Calcification of the seminal vesicles is also very uncommon. This subject has been discussed under Calcification of the Vas Deferens, Ampulla and Seminal Vesicle (p 532)



### 3. Diseases of the Ejaculatory Duct

The ejaculatory ducts, because of their intimate relation to the posterior urethra, verumontanum, prostate, and seminal vesicles, all of which are very prone to infection, are constantly exposed to bacterial invasion. Inflammatory edema, or the later infiltrative changes in the connective tissue produce obstruction of the ducts, giving rise to sterility, functional impotence, and various other sexual neuroses. In chronic posterior urethral infections, both gonorrheal and non-specific, infiltrative and granulomatous changes in the verumontanum are likely to result in constriction of the terminal portions of the ejaculatory ducts. Unless the ducts are kept open, stasis will take place in the genital tract above, and the way prepared for extension of the infection by surface continuity.

Because of their similar structure, the pathological changes in the ejaculatory duct are akin to those in the vesicle, and have already been described in connection with diseases of the vesicle.

### 4. Diseases of the Seminal Vesicle, Vas Deferens, and Ejaculatory Duct in Children

Diseases of the seminal vesicle, vas deferens, and ejaculatory duct in children are very rare. In sarcoma of the prostate in children the seminal vesicles become secondarily involved early. Tuberculous vesiculitis is sometimes seen, usually as part of a urogenital tuberculosis. Any other type of vesiculitis is usually a sequel to a urethral infection.

When diseased seminal vesicles are encountered in children, they are treated in the same manner as in adults.

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## CHAPTER XV

### OPERATIVE AND NON-OPERATIVE TREATMENT OF THE VAS DEFERENS, SEMINAL VESICLE, AND EJACULATORY DUCT

#### A OPERATIVE TREATMENT

##### *1 Operative Treatment of the Vas Deferens*

###### *Anesthesia*

Local anesthesia—usually infiltration of novocaine, 1 per cent—is satisfactory for operations upon the vasa deferentia as a rule

###### *Preoperative Preparation*

Preoperative preparation consists of the usual preliminary purgation and enema

###### *Preparation of the Skin*

The operative site to be prepared includes both the scrotum and the lower body wall over the inguinal canal of the affected side. This area is carefully shaved and scrubbed with green soap and warm water. It is sterilized by spraying with tincture of zephiran, 1 1,000, tincture of merthiolate, 1 1,000, or other preferred antiseptic solution.

###### *Position of Patient on Operating Table*

The patient is placed on the operating table in the dorsal position.

###### *Vasotomy*

- **Indications** Vasotomy enjoyed a considerable vogue a decade or so ago in the treatment of chronic infections of the vasa deferentia, seminal vesicles, and epididymes. Its waning popularity has been due to the fact that stricture of the vas was found to have followed the operation in the majority of cases. It is still advocated however by some surgeons, both for therapeutic purposes and for the injection of vesiculographic solutions.

We much prefer the opposite method of approach—that is, by retrograde catheterization of the ejaculatory ducts through a urethroscope (p. 563). This method allows unlimited treatment of the vasa and vesi-

cles by injections into the ejaculatory ducts, or repeated vesiculographies, without loss of patency

**Technic of Vasotomy** Under local anesthesia the vas deferens is isolated and exposed by an incision 2 cm long made through the skin and the envelops of the spermatic cord, and its canal opened by a small longitudinal incision. Through this, a blunt hypodermic needle may be introduced—usually for the purpose of injecting therapeutic substances or for the introduction of an opaque medium preliminary to vesiculography

A suture having three functions—to guide the needle during the daily injections, to keep the lumen of the vas patent, and to close the fistula when the treatment is completed—should be passed through the lumen of the canal at each cut surface and out through the wall of the vas 1 cm distant from the cut end. One end of the suture is then pushed through the skin and the two ends are loosely tied on the outside. To close the fistula, one has only to tighten this suture until the cut surfaces of the vas are approximated.

The vas and vesicle can usually accommodate from 4 to 6 cc of a non irritant liquid such as rivanol dextrose. None of the solution escapes through the ejaculatory duct until the vas and vesicle are filled because this exit is closed by a sphincter. This muscle yields to over flowing of the seminal duct, the solution passing into the prostatic urethra and thence usually backward into the bladder but occasionally forward into the anterior urethra, escaping at the meatus. An unlimited quantity of solution may thus be used to irrigate the vas, vesicle, ejaculatory duct, prostatic urethra, and utricle, and this irrigation may be repeated at the discretion of the operator.

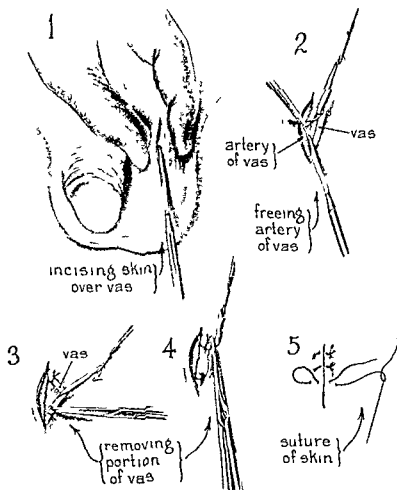
The first injection of the vesicle should not exceed 30 minims, if much more is used, there may be spermatic colic due to contractions of the vesicle, or even urinary retention. When the inflammation begins to subside, the amount of irrigation fluid may be guardedly increased.

### *Vasectomy*

**Indications** Bilateral vasectomy is an almost routine preliminary to prostatectomy, as a preventive of epididymitis.

**Technic** Under local anesthesia, a 3 cm incision is made in the upper part of the scrotum and carried down through the intervening tissues until the cord is exposed. The vas is identified and isolated from the other structures of the cord for a distance of about 3 cm. The denuded portion of the vas is ligated with catgut at either end, the

ligatures are tied tightly, and the intervening section is excised, the cut ends being cauterized with carbolic acid, 95 per cent and alcohol, 70 per cent.



Wm P Didusch 1932

FIG 111 Vasectomy (1) A 3-cm incision is made in the upper part of the scrotum, exposing the vas deferens (2) The vas is freed from the surrounding structures, the isolated portion ligated with catgut at each end (3), and the intervening segment removed (4) (5) Final skin closure

The wound is closed in layers, the subcutaneous tissue being approximated with plain catgut and the skin with silk, dermal, or silkworm gut. Ordinary dry dressings allow the wound to heal promptly.

*Anastomosis of the Vas Deferens*

**Indications.** Anastomosis of the vas deferens is necessary when it has been accidentally severed during operation or by other traumatic injury

**Technic.** The severed ends of the vas deferens are isolated for about

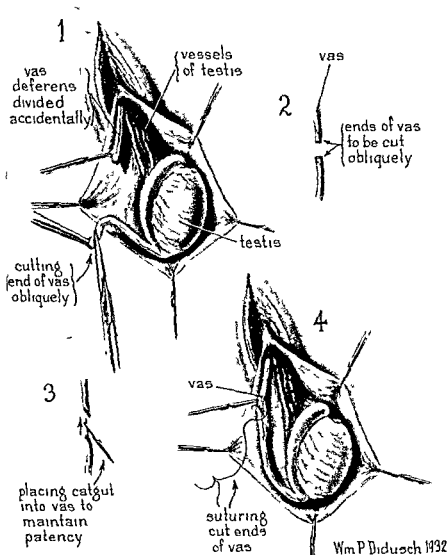


FIG 112 Anastomosis of the vas deferens, following accidental severance (1, 2) The severed ends of the vas are isolated for about 3 cm from each cut end, and cut obliquely (3) A piece of catgut is placed into the vas to assure its patency (4) The vas is then sutured together with 4 or 5 silver wire sutures, which are passed through the perideferential tissue

3 cm from each cut end. A catgut suture, studded with an atraumatic needle, is passed into the lumen of the distal end of the vas, being introduced through the wall about 3 cm from the severed end, and brought out of the lumen at the cut end. The needle is then threaded through the lumen of the proximal end and brought out through the wall of the vas, about 3 cm from its end. The catgut is pulled sufficiently to assure its end being well within the lumen of the vas.

The vas is then stitched together with 4 or 5 silver wire sutures, which are passed through the perideferential connective tissue, thus securing union with the lumen continuous (as assured by the catgut left within it).

The wound is closed in layers, the catgut being brought out through the wound and fixed in such a manner that it cannot be pulled out of position. Leaving the catgut in the lumen assures the patency of the vas.

## *2 Operative Treatment of the Seminal Vesicle*

### *Anesthesia*

We prefer spinal or sacral anesthesia to general inhalation anesthesia except in the case of children and non cooperative patients for whom general inhalation anesthesia is to be preferred.

### *Preoperative Preparation*

The patient is given the usual preliminary purgative and soap-suds enema, and preliminary medication (Preliminary Medication, p. 191).

### *Preparation of the Skin*

The operative field includes the perineum and the scrotum. This area is shaved and carefully scrubbed with green soap and warm water. It is sterilized by spraying with tincture of zephiran, 1:1,000, tincture of merthiolate, 1:1,000, or other preferred antiseptic.

### *Position of Patient on Operating Table*

The patient is placed on the operating table in the exaggerated lithotomy position.

### *Seminal Vesiculotomy*

**Indications.** Incision and drainage of the seminal vesicles is an operation which formerly was done very frequently but now is done much less often. Seminal vesiculotomy is, however, a very useful procedure when there is pyogenic infection of the vesicles which is not being properly drained through the ejaculatory ducts.

Before performing a vesiculotomy the patient should be advised that



there is often a period of impotence (2 or 3 months) following this procedure, in fact, permanent impotence has been caused in some cases. Usually the impotence can be relieved by the Lowsley operation (p. 350).

**Technic** The vesicles are exposed in the manner described under Seminal Vesiculectomy.

An incision is then made in each of the distended vesicles and several incisions in the posterior surface of the prostate gland. Small, soft rubber tubes are inserted into the vesicles for drainage. The two sides of the levator ani muscle are sutured with a single catgut suture, and the perineal wound is closed by silkworm gut, the two rubber drains being brought out through the perineal wound and tied with the suture material. Dry dressings are applied.

Cultures are always made of the released fluid.

The tubes are left in position until drainage ceases, and are then removed.

**After-care** It is often necessary to treat these patients with hot rectal douches, vesicular massage and other palliative measures as soon as the patient has recovered from the vesiculotomy.

### *Seminal Vesiculectomy*

**Indications** Seminal vesiculectomy is usually performed for tuberculosis, malignancy, certain cases of abscess, or marked inflammation with obliteration of the lumen of the vesicle.

As with vesiculotomy, the patient should be warned of the possibility of temporary or even permanent impotence following this procedure.

**Technic** The technic employed by us is as follows. The patient is placed on the table in the exaggerated lithotomy position. A sound is introduced into the bladder, then removed, and a Lowsley prostatic tractor passed into the bladder. This is opened, and the prostate and seminal vesicles are pulled up as far as possible.

An inverted V incision is made in the perineum and deepened into the rectal fossa on each side. The central perineal tendon is exposed and incised posterior to the junction of the lateral perineal muscles. The anterior tractor is placed behind the transverse perineal muscles, which are pulled upward. A Kocher clamp is fixed to the V shaped flap, which is held in the hand, and the gloved finger is placed in the rectum (to avoid trauma to that structure) and protected with a towel.

The apex of the prostate is located, the recto-urethralis muscle cut, and the levator ani muscle dissected free from the posterior surface of the prostate and seminal vesicles, which is recognized by its glistening

fascia of Denonvilliers. The finger is removed from the rectum and the glove changed.

The rectum is separated from the posterior surface of the seminal vesicles and held out of the way with a gauze covered posterior retractor.

A transverse incision is then made into the three layered posterior portion of the reflection of the peritoneum covering the vesicles thus allowing the finger of the operator to enter the envelop, which contains the vesicles.

The seminal vesicles are freed from the surrounding structures by enucleation with instruments and the finger, and grasped with the Lowsley forceps. It has been found advisable to deliver both vesicles before excising either, as traction on the vesicle first isolated simplifies dissection of the other. A ligature is placed around the base of each vesicle and it is then excised the ends being cauterized with carbolic acid 95 per cent and alcohol, 70 per cent.

The cavities whence the seminal vesicles have been removed are drained by means of small, soft rubber tubes which are attached to the stump of each vesicle and brought out on either side of the skin incision.

The two sides of the levator ani muscle are sutured with a single stitch of plain catgut, the central tendon is reunited and the skin is closed by silk or dermal the two rubber drains being tied with the suture material. Dry packing is then applied.

After care. The attendant's shock in this type of operation is usually not great and patients require little postoperative care of a special nature. Careful follow up is insisted upon in such cases.

### *Radical Removal of the Seminal Tract for Tuberculosis*

This operation has already been described on page 510.

### **B. NON OPERATIVE TREATMENT OF THE VAS DEFERENS, SEMINAL VESICLE, AND EJACULATORY DUCT**

Most cases of inflammation of the vas deferens ampulla seminal vesicle and ejaculatory duct respond to non-operative treatment and it rarely becomes necessary to operate except when abscess forms or when there is no response to a long period of urological treatment.

The non-operative measures most often employed in these cases are catheterization and injection of the ejaculatory ducts, massage and stripping of the vesicles, hot rectal douches, diathermy, urethral dilatation, sulfonamide therapy, vaccines and bacteriophage and attention to personal hygiene and diet.

*Catheterization and Injection of the Ejaculatory Ducts*

With the perfecting of special instruments and improvement in technic, catheterization of the ejaculatory ducts seems destined to supersede vasotomy and the once popular vesiculotomy in the treatment of seminal vesiculitis. Retrograde catheterization of the ejaculatory ducts has been proved a practical, painless, and non traumatic procedure if properly done on the prepared patient. Moreover, it can be repeated at will. Its chief uses are (1) for lavage of the vesicle and the injection of antiseptics, (2) for dilatation of the ejaculatory duct to secure more complete drainage, (3) for the injection of vesiculographic solutions, (4) for the obtaining of uncontaminated vesicular secretion for chemical and microscopic study.

The procedure may be accomplished by employing an operating urethroscope, such as the Lowsley urethroscope (p 90) or the instrument more recently developed by Peterson at the Brady Foundation, of the New York Hospital (p 94), or any ordinary urethroscope may be pressed into service in conjunction with special catheterizing devices. There have been constructed several kinds of probes, filiforms, and bougies of metal and whalebone for the exploration and treatment of the ejaculatory ducts, seminal vesicles, and vasa deferentia. The one devised by Delzell, and McCarthy's instrument for catheterization of the ejaculatory ducts, are useful examples.

The antiseptic substances used are the same solutions employed in the treatment of urethral infections and usually take the form of instillations, as only rarely can one irrigate the ejaculatory ducts, seminal vesicles, and ampullae. We have found a 5 per cent solution of mild silver albuminate to be the least irritating.

It is useless to attempt catheterization of the ejaculatory ducts without previous urethral dilatation and observation endoscopy. Orientation in the posterior urethra and on the verumontanum is none too easy when the features are distorted and instrumentation productive of disconcerting bleeding. Localization of the ejaculatory ducts on a verumontanum that has been cleared of granulations is not difficult. Should they escape observation, touching up the verumontanum with phenolglycerine will render the smallest detail visible. Ducts opening within a deep utricle, and therefore impossible to catheterize, are rarely seen. Large and exposed ejaculatory duct orifices are most likely to have infected vesicles behind them.

For dilatation of the ejaculatory ducts, olive tip catheters are more

practical, while the whistle tip is preferable for injection. The use of a wire stylet may be advisable, to prevent buckling of the catheter. Catheters should be inserted carefully and passed slowly, by short degrees, to a depth of 3 to 5 cm. Ordinarily, a No. 4 F catheter will pass the entire length of the ejaculatory and seminal duct without difficulty. Entrance of the catheter into the ampulla is a common occurrence. Stricture, angulation, or compression of the duct may make the passage of the catheter difficult or impossible. In such cases a No. 4 F oliveary bougie can be tried, using the lightest possible touch. Forced passage will only cause more scarring, with distortion and will reduce the chances of future success. It is easy to perforate the verumontanum and arrive in the bladder or in the depths of the prostate with but little pain to the patient. On the other hand as many as 9 or 10 consecutive careful catheterizations need not damage or distort the verumontanum to any extent. Gradual dilatation of edematous ejaculatory ducts through 6 or more sessions has made vesiculography possible in the most difficult cases.

Our clinical experience, controlled by repeated vesiculographies shows that the therapeutic factor in seminal catheterization is the mechanical dilatation of the ducts rather than the injection of antiseptic solutions. *Vesicles treated by dilatation alone regained their normal contours just as well as those that were injected.*

Following successful catheterization, the patient should be instructed to procure elimination of the vesicular contents within 2 to 3 hours by means of intercourse, thus eliminating the danger of epididymitis following catheterization of the ducts.

Catheterization may be repeated every 3 to 6 weeks until good drainage has been established. In the interim the patient should be given vesicular and prostatic massages, which should alternate with intercourse at regular intervals.

### *Massage and Stripping of the Seminal Vesicles*

Massage and stripping of the seminal vesicles play a dominant rôle in the treatment of these organs. Although the terms "massage" and "stripping" are frequently used as synonyms, these two types of digital manipulation are dissimilar in technic and indications.

**Massage.** Massage of the seminal vesicle is the application by the finger tip of numerous short strokes, placed along the entire circumference of the gland. The strokes are made in an overlapping manner

to the center of the vesicle, without traversing it. The upper edge of the vesicle is massaged by flexion of the end phalanx of the finger, its tip exerting a slight downward pull. The lower margin of the gland is massaged by a supinating motion on the right side and pronation on the left, an attempt being made at each stroke to mobilize the vesicular margin. The massage should be gentle and prolonged, and continued around the vesicle 3 or 4 times. It is usually given twice a week upon a bladder containing at least 200 cc of rivanol dextrose or acriflavine, 1:5,000.

The maneuver is best carried out with the patient in the knee elbow position, or he may stand bent over a table or low backed chair, with his heels separated and toes turned slightly inward so as to insure a firm stand. By using the middle finger instead of the index finger, 1 to 1.5 cm is added to the reach. The tactile sense and mobility of this finger can be developed with a little practice.

*Bimanual massage* may be resorted to in an attempt to reach the terminal pole of greatly enlarged vesicles, or when enlargement of the prostate has displaced the glands upward and laterally. As the finger within the rectum moves laterally and upward, the other hand is placed upon the abdomen so that its fingers appose the rectal finger. The vesicle can be recognized by the peculiar feeling it imparts to the apposing fingers as it slips back and forth between them. Both hands have a part in the massage and compression of the vesicle which lies thus between them. This procedure is more difficult of accomplishment than the single finger method, but its results are worthy of some pains in acquiring the skill necessary for its successful application.

Seminal vesicular massage is indicated in cases of partial obstruction of the ejaculatory ducts with impeded drainage and narrow adhesions. Such massage promotes (1) a slow expression of the vesicular contents under low pressure, (2) local hyperemia with increased secretory function and resorption, (3) normal peristalsis, (4) contraction of the vesicular capsule, (5) the stretching and final removal of adhesions.

The amount of secretion expressed from both vesicles by massage or stripping can vary from a few cubic centimeters to as much as 2 ounces. The secretion may be recovered from the bladder contents, voided immediately after massage or stripping. The bladder should be filled, before manipulation is undertaken, with rivanol dextrose or acriflavine, 1:5,000, in which seminal secretion coagulates. By repeatedly filling and emptying the bladder after massage of the prostate, left vesicle, and right vesicle

respectively, a comparative analysis of the amount and composition of the individual secretion of all three glands can be made. The secretion may also be collected in sterile endoscopic tubes.

**Stripping** Stripping of the seminal vesicle is accomplished by the flat surface of the end phalanx of the finger used. Because of the larger area of contact, the force may be considerably greater than that applied in massage. The strokes should be slow and uninterrupted and should cover the gland from the terminal pole to the ejaculatory duct. Four to six strokes to each vesicle once or twice a week is the extent to which stripping can be safely applied.

Stripping of the vesicles effects a thorough drainage through wide-open ejaculatory ducts only. It is particularly useful in late stages of catarrhal vesiculitis, where the normal contractibility of the gland and its capsule are lost. It is not effective in the solution of adhesions or the creation of hyperemia. Forced stripping in cases with partial or complete obstruction of the ejaculatory ducts results in poor drainage, deferential reflux, intraglandular and subcapsular hemorrhage and rupture of the vesicles (Rolnick). A gentle stripping provides a more thorough drainage of the vesicle than either massage or ejaculation provided that the ejaculatory duct is fully open, but if patency of the efferent duct is impaired, a moderately forceful stripping can force the vesicular contents into the vas deferens. This explains the frequency of epididymitis, when drainage is attempted before sufficient provision has been made for it (Peterson).

### *Vas Puncture*

It must be kept in mind that vasotomy and vas puncture are two distinct procedures. Vasotomy involves not only isolation of the vas deferens but also a real opening into its lumen, with the attendant dangers of infection and stricture or possible sinus formation. Vas puncture consists of a simple puncture of the slender tube with a fine needle which permits the injection of the desired medicament without in any way compromising the lumen of the vas. It does not of course afford any drainage.

### *Methods of Applying Heat in the Treatment of the Seminal Vesicles*

Hot rectal irrigations are helpful in alleviating pain and swelling of the seminal vesicles. These are given at a temperature of from 110 to

112°F, copious irrigations being administered 2 or 3 times daily. The rectum is capable of enduring a high degree of heat applied in this manner, and results can frequently be obtained by the use of moist heat which cannot be otherwise attained.

A simple but entirely satisfactory method of applying heat consists in attaching a funnel to an ordinary rectal tube, pouring hot water into it, holding it a while, and then allowing it to empty. This is repeated for from 15 to 30 minutes according to the patient's tolerance and need for it.

Several machines for the application of heat have been devised. The one put forward by Elliott is a good example of the use of hot water in a rubber bag to accomplish this purpose.

Diathermy, by means of the short wave, has been found very useful in the treatment of inflammation of the vesicles, and is well worth a trial. It is usually applied twice a week for about 20 minutes at a sitting.

#### *Vaccines and Bacteriophage*

Occasionally, in the resistant cases, vaccines may be of great therapeutic value. These may be autogenous or mixed. Vaccines undoubtedly increase the resistance of the blood to the infecting bacteria which have penetrated below the mucosa where they are not reached by irrigations. In obtaining the material for autogenous vaccines the urethra is thoroughly irrigated and the sterilized urethroscope passed with the patient in a kneeling posture. He is then required to bend over and the seminal vesicles are stripped. The fluid will pass into the endoscopic tube, whence it may be removed under sterile precautions for culture and the preparation of the vaccine.

Bacteriophage is occasionally utilized in this type of case, and some authors are enthusiastic regarding their results.

#### *Chemotherapy*

It has been proved beyond a doubt that the sulfonamide drugs, properly administered in combination with suitable urological measures, are capable of eradicating the microbic agents that are chiefly responsible for the various types of infections (gonococcal and non specific) in the seminal vesicles (p. 1162). Other useful drugs are pyridium, which has a soothing effect on the mucous membrane of the genito urinary tract, and calcium or ammonium mandelate, alone or combined with methenamine.

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## CHAPTER XVI

### EMBRYOLOGY, ANATOMY, ANOMALIES, AND PHYSIOLOGY OF THE FEMALE EXTERNAL GENITALIA

#### A EMBRYOLOGY OF THE FEMALE EXTERNAL GENITALIA

During the first 6 or 7 weeks of intrauterine life the development of the external genitalia proceeds similarly in both sexes (Embryology of the Penis, p 223) This is known as the "indifferent" period In the seventh week, when the embryo is about 16 mm long, they begin to take the form of male or female

**Genital Tubercle Period** Very early in embryonic life there develops in the midline of the ventral body wall, between the primitive tail and the umbilical cord, the *genital tubercle* When the embryo is 8 mm long, the shallow *urethral groove* appears on the caudal slope of this eminence As growth proceeds, the genital tubercle is transformed into a compressed conical protuberance At about the 13 mm stage, the phallic portion of the urogenital sinus opens through to the exterior by splitting of the urogenital membrane, and forms the slit like primitive *urogenital opening*

Sex differences begin to be evident at 16 to 17 mm, when the male may be distinguished by the greater length of the urethral groove and the relations of the urethral folds to the labioscrotal swellings

**The Phallus Period** When the embryo is about 17 mm long (seventh week), the genital tubercle becomes elongated into a narrow conical structure, the precursor of the *clitoris* in the female The margins of the urogenital opening called the *urethral folds*, form the *labia minora* The *labia majora* are formed by the development of the *labioscrotal swellings*, a pair of rounded lateral ridges at the base of the phallus and separated from it by a groove In embryos 21 to 26 mm long, the apex of the phallus is clearly marked off by the *coronary sulcus*, which separates the *glans* from the basal shaft

The urogenital opening in the female is limited to the shaft of the phallus and does not extend to the tip, as in the male

**Definitive Period** The real differentiation between the male and female external genitalia occurs between the lengths of 38 and 45 mm

In the male embryo the phallus now rapidly enlarges and elongates to form the penis, but in the female it lags in development and becomes the clitoris. This organ, although similar to the penis in shape and possessed of a glans and a prepuce, remains small, and the shorter urethral groove never extends upon the glans, as in the male.

In the female, the labioscrotal swellings gradually progress downward and unite caudally in front of the anus to form the *posterior commissure*, laterally they persist as the right and left *labia majora* and above as the *mons veneris*. The *labia minora* are formed by the urethral folds, which, in the female, enlarge and remain open, surrounding the urethrovaginal orifice.

**Development of the Vagina** The vagina arises from the uterovaginal anlage, which is formed by fusion of the caudal portions of the müllerian ducts.

The müllerian ducts appear in an embryo 5 to 6 mm long as evaginations of the coelomic epithelium lateral to the cranial extremities of the mesonephric (wolffian) bodies. They follow the course of the mesonephric ducts, growing independently of them. At first lateral in position, the müllerian ducts cross the mesonephric ducts and enter the genital cord median to them. In the male, the ducts degenerate after reaching Muller's tubercle. In the female, they persist and grow, the caudal ends uniting after reaching Muller's tubercle (in embryos of about 21 mm) to form the uterovaginal canal, from which develop the vagina, cervix, and uterus. The cranial ends remain separated and form the fallopian tubes.

The development of the vagina may be divided into four stages (Koff, 1932). First, there is the formation of the uterovaginal canal from fusion of the caudal longitudinal portions of the müllerian ducts. The müllerian segment of the vagina develops from the fused müllerian ducts when the embryo is between 30 and 56 mm. The vaginal epithelium becomes stratified at 38 mm length. Secondly, the sinovaginal bulbs of the urogenital sinus develop when the embryo is about 63 mm long. Thirdly, the uterovaginal canal becomes solidified by stratification and fusion of the cells lining the cavity and by growth of these cells. The primitive vaginal plate is formed by the fusing of the two vaginal primordia to form a single cord, which increases in size. Lastly, in fetuses of 150 to 200 mm, the center of the cord becomes hollowed out by degeneration of the central epithelial cells, which are discharged through the hymen.

**Development of the Hymen** The hymen is formed at the area of evagination of the urogenital sinus to produce the sinovaginal bulbs, which persist as paired lips. The connective tissue between the vagina and the urogenital sinus forms a plate and becomes the unpaired segment of the hymen. The hymen, therefore, is derived from the urogenital sinus.

## B ANATOMY OF THE FEMALE EXTERNAL GENITALIA

The external genitalia of the female consist of the mons veneris, labia majora, labia minora, clitoris, and the vestibule—the last containing the urethral orifice and the vaginal orifice, protected by the hymen. Collectively, these structures, with the exception of the mons veneris, are known as the *vulva*.

**Mons Veneris** The mons veneris is a rounded prominence situated in front of and above the cleft of the vulva, and is formed by union of the labia majora. It consists of subcutaneous fat, and after puberty is covered with hairs.

**Labia Majora** The labia majora are the rounded, longitudinal folds of skin and adipose tissue which form the lateral boundaries of the vulva. They are homologous to the male scrotum. The labia majora usually measure 8 or 9 cm. in length and 3 or 4 cm. in width. They unite superiorly to form the mons veneris and posteriorly become the posterior commissure. They are covered with hair after puberty, are richly supplied with sebaceous glands, and are sufficiently thick to contain nerve terminals and blood and lymph vessels, as well as the structure corresponding to the dartos in the male.

**Labia Minora** The labia minora are the lesser, inner lips of the vulva. They are paired, short, thin, longitudinal folds of mucous membrane situated within the labia majora, each labium fusing with the inner surface of its corresponding labium majorum. The labia minora converge anteriorly, splitting into two thin folds which embrace the clitoris to form the *frenum* of the clitoris and cover the glans. They diminish in size posteriorly and are connected by the *fourchette*. Between the fourchette and the vaginal orifice is the *fossa navicularis*.

**The Clitoris** The clitoris is the homologue of the male penis. It averages 2 to 4 cm. in length and 0.25 to 0.5 cm. in diameter. In structure it is very similar to the male penis, being formed of cavernous and erectile bodies, but the corpus cavernosum is much smaller and does not convey the urethra, as in the male. It has paired corpora cavernosa

and paired vestibular bulbs which are joined anteriorly to the glans. The rounded tip of the clitoris, known as the *glans clitoridis*, is the homo-

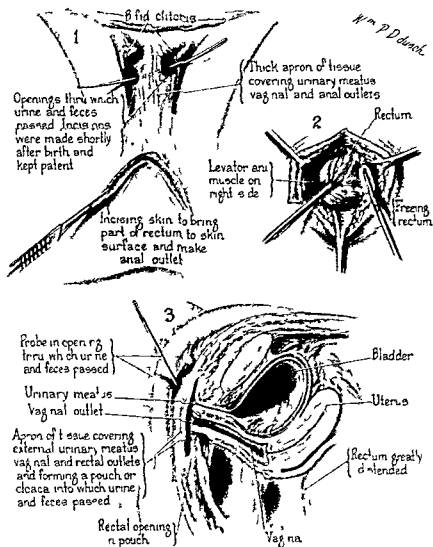


FIG. 113 Congenital abnormality in a 9-year-old girl consisting of imperforate anus, urethra, and vagina operation to cure condition. (1) Showing the condition present. (2) Incision made to free loop of bowel and make new anal outlet. (3) Sagittal section showing the conditions present (Lowrey's case)

logue of the glans penis. It has no special sexual function but is the seat of many nerves making it highly sensitive to stimulation.

The clitoris occupies the midline below and slightly posterior to the mons veneris. It is held in position by the suspensory ligament, which

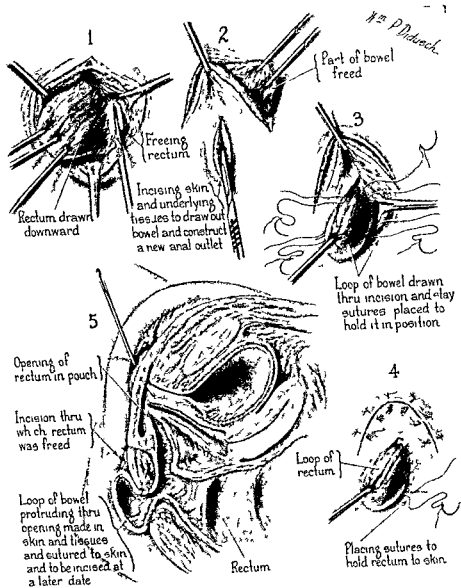


FIG 114 Operation for imperforate anus, urethra, and vagina (1) Freeing the rectum (2) Incising the skin and underlying tissues to construct a new anal outlet (3) Drawing the loop of bowel through the incision and placing stay sutures to hold it in position (4) Loop of bowel sutured in position Final skin sutures being placed (5) Sagittal section showing condition present after the operation (Lowsley's case)

is attached to the symphysis pubis. Though the clitoris consists of two crura, a body, a suspensory ligament, and a glans, the prepuce and

frenum which are formed by the labia minora completely conceal all but the glans

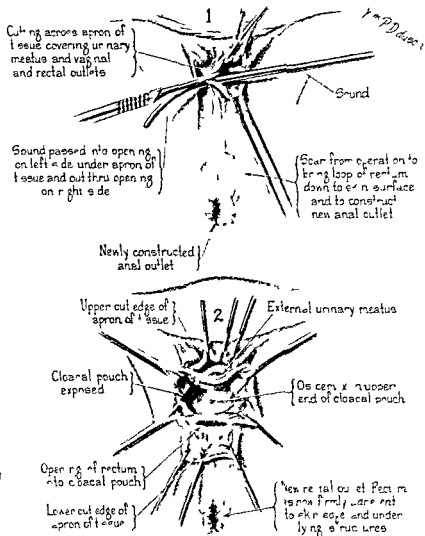


FIG. 115. Operation for imperforate anus, urethra, and vagina. (1) Dividing the apron of tissue covering the urinary meatus and the vaginal and rectal outlets. (2) Condition present after division of the apron of tissue. (Lowsley's case.)

**The Vestibule** The vestibule is the unfused urethral groove of the sexually indifferent embryo. It is a triangular space having its apex at the clitoris and its base at the fourchette, and is enclosed by the labia minora.

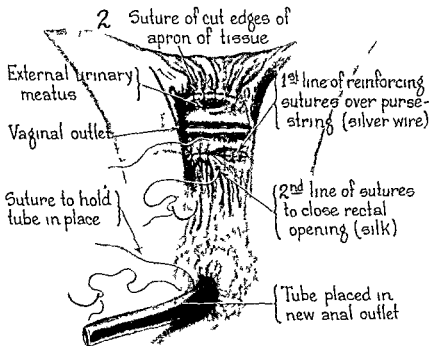
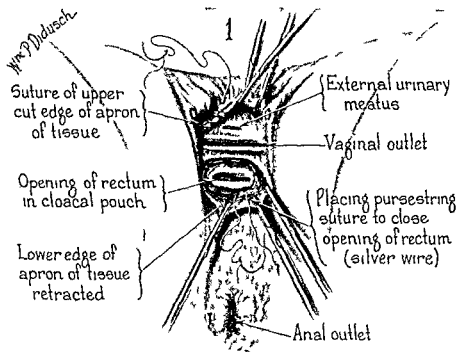


FIG. 116 Operation for imperforate anus, urethra and vagina. (1) Suturing the upper cut edge of apron of tissue and placing a purse string suture of silver wire to close the abnormal anal opening. (2) Cut edges of apron of tissue sutured. Purse string suture tied closing the abnormal anal outlet. Two lines of reinforcing sutures were placed over the purse-string. After this operation the patient had a normal urethral opening, vaginal orifice with cervix and a artificial anus with a good sphincter. When discharged from the hospital she had control of both urine and feces. (Lowsley's case.)

The urethral orifice is situated about 2.5 cm below the clitoris, being separated from it by a triangular area of smooth mucous membrane. Just inside the puckered urethral meatus are the orifices of *Skene's glands*, which are generally regarded as the homologue of the male prostate.

The vaginal orifice is just below the urethral meatus and is protected by the *hymen*, a thin, vascular fold of mucous membrane attached around the vaginal introitus. In young girls the hymen is sometimes imperforate, and in other cases it is entirely absent. Ordinarily, it has a small crescentic perforation in its center. After being ruptured at coitus, its edges become irregular, and are called *carunculae hymenales*.

On either side of the vaginal orifice, situated beneath the superficial fascia, are the *glands of Bartholin* (vulvovaginal glands). Their ducts open on each side of the fossa navicularis, just outside the hymen. Their function is to lubricate the vulva to permit intromission of the penis. On sexual stimulation they secrete an oily, yellowish secretion.

### C ANOMALIES OF THE FEMALE EXTERNAL GENITALIA

Congenital anomalies of the female external genitalia are relatively common, and may be associated with malformations of other structures.

In a very interesting recent case of Lowsley's in which the patient was a 9 year-old girl, there was wide separation of the pubes, recti muscles, and labia, with bifid clitoris, and complete absence of the urethral, vaginal, and anal orifices. Just below the location for a normal urethral opening there was a fistulous tract on each side, from which exuded urine and feces. A perineal incision was made in the region where the anus should be, and carried down to the pelvic floor, revealing excellent levator ani muscles and disclosing a dimple surrounded by a fairly good sphincter muscle. This opening was enlarged, and an artificial anus created by bringing the rectum down through it and suturing it so that it protruded outside. Five days later this distal loop of the rectum was opened with the coagulating current and a large catheter inserted. This artificial anus was irrigated and dilated for 2 weeks. An operation was then done for closure of the rectal entrance into the cloaca and division of the vaginal septum. An incision was made from one lateral fistulous opening to the other, allowing the cloaca to be opened wide. Examination showed a cervix on its upper portion, and in the lower anterior midline, at the skin margin, a fairly normal appearing urethral orifice. A sound passed through this entered the bladder.



releasing urine. The rectal opening was next to the skin margins in the midline, and was about  $\frac{3}{4}$  inch in diameter. The rectal fistula was closed. After this operation, the patient had a normal urethral opening, vaginal orifice with cervix, and an artificial anus with a good sphincter. Although unable to tell when her bladder was distended, she was taught to empty it at regular intervals by pressure over the symphysis. When discharged, she had control of both urine and feces (Figs 113 to 116).

### *Anomalies of the Clitoris*

The clitoris may be absent, hypertrophied, or atrophied. These anomalies are associated usually with some endocrine disturbance.

*Adherent clitoris* results in irritation and the accumulation of secretions which may give rise to masturbation and associated nervous symptoms. In such cases, severance of the adhesions is indicated.

### *Anomalies of the Vagina*

*Congenital absence* of the vagina is rare in living women, and, associated with functioning internal genitalia, is almost unknown. It therefore offers no clinical problems.

*Congenital atresia* of the vagina usually affects only the lower end. It is due to imperfect canalization in the fused müllerian cords, resulting in obstruction at some point in the vagina. If only a thin septum is present, it should be incised to let out the collected menstrual blood, and then partially or wholly excised. If the obstruction is more extensive, treatment requires plastic measures, depending on the conditions present. Attempted restoration of the vagina should be undertaken only after careful rectoabdominal examination to establish the normalcy of the uterus.

*Complete duplication of the vagina and uterus*, with each canal having separate walls, is very rare, and is due to failure of the müllerian ducts to fuse. Usually, double, or septate, vagina consists in a longitudinal septum dividing the vagina into two canals, and is generally associated with similar malformations of the upper tract. It is due to incomplete resorption of the fused müllerian ducts. The septum may extend only part way, or it may traverse the entire length of the vagina, giving two openings at the vestibule. It may cause severe complications during labor or interfere with coitus. If the septum is causing disturbance it should be divided or, better still, excised.

*Imperforate Hymen*

The only anomaly of the hymen of clinical importance is congenital atresia or imperforate hymen associated with normally functioning internal genitalia

**Etiology** Two theories have been suggested to account for this anomaly (1) that the hymen is the remains of the septum between the embryonic vagina and the urogenital sinus and that failure of the septum to break down results in imperforate hymen (2) that the hymen is of separate embryonic development and that imperforate hymen is due to excessive proliferation and coalescence of the area just behind the septum rather than to its failure to regress

**Symptoms Signs and Diagnosis** As a rule it causes no disturbance until puberty. Then menstrual blood collects back of the imperforate hymen gradually increasing in amount until it distends the vagina uterus and even the fallopian tubes forming a fluctuating tumor. There are periodic attacks of the usual disturbances accompanying menstruation but menstruation fails to occur. As the collection of blood increases the symptoms become more marked and the general health suffers.

**Diagnosis** is made on the history and physical examination. The latter will reveal absence of the hymenal opening and the presence of a fluctuating mass occupying the position of the vagina or uterus or within the tubes according to the duration of the condition.

**Treatment** Treatment is dependent upon the findings. Incision of the distended hymen is always necessary to permit of adequate drainage. If the membrane is thick most of it should be excised. If there is evidence of a tubal tumor laparotomy will be necessary. Elaborate aseptic precautions are necessary in every case to prevent infection due to the toxicity of the retained menstrual blood.

*Hypospadias*

Hypospadias in the female is uncommon and is in no sense similar to hypospadias in the male. It is the term applied to the anomalous condition in which the urethra opens on the anterior wall of the vagina. In some animals (i.e. the female dog) the urethra always opens at this point.

**Etiology** The malformation results from failure of the fused caudal ends of the mullerian ducts to assume their usual deep position thus leaving a gap where the urethrovaginal septum ordinarily develops.

**Pathology** The urethra and vagina may be malformed in a variety of ways as a result. Both or either of these structures may be divided

The vagina may open into the urethra, or the shortened urethra may open above an imperfectly developed vagina. The urethra may be so short as to seem obliterated and the bladder open directly into the vagina. Malformations of the clitoris and labia majora sometimes accompany this condition.

**Symptoms, Signs, and Diagnosis** Incontinence is probably the most frequent complaint of patients suffering from this anomaly. It may be complete or partial, depending on whether or not the sphincter vesicae is absent. Sometimes there is obstruction to urination, due to the unusual location of the urethra. Associated vaginal defects may make sexual intercourse difficult or impossible.

The diagnosis is easily made by inspection, with or without instrumentation. Cystograms will reveal whether there is vesico ureteral back pressure in cases of long standing obstruction to urination.

**Prognosis** The higher grades of deformity are difficult to relieve, as are all anomalies requiring plastic operations. We have obtained good results in some cases by the ribbon gut technic of Lowsley (p. 1137) when incontinence is the chief complaint.

**Treatment** The milder grades of hypospadias, with no urinary disturbances, do not require treatment. Simple dilatation of the urethral meatus will sometimes relieve the obstructive cases. The surgical treatment of hypospadias in the female is discussed on page 603.

### *Epispadias*

Epispadias is partial or complete absence of the roof of the urethra. It is very rare in both sexes, and occurs much less frequently in the female than in the male.

**Etiology** This is a developmental defect, and may be partial or complete. It always accompanies exstrophy of the bladder, in which case the symphysis is lacking.

**Pathology** The malformation may vary from cleft clitoris to complete exstrophy of the bladder (Fig. 35). There may be a normal urethra opening above the clitoris, or there may be a cleft clitoris, with more or less deficiency of the dorsal wall of the urethra—the urethra appearing as a gutter above the clitoris. In the severer grades there may be complete absence of the anterior urethral wall and the anterior half of the vesical sphincter, or the splitting and arrested development of the urethra may be accompanied by splitting of the symphysis pubis and exstrophy of the bladder.

**Symptoms, Signs, and Diagnosis** In the milder cases, where there is neither incontinence nor sexual dysfunction, the condition may be

discovered only by accident. If the clitoris is cleft, there may occasionally be some sexual disturbance. In the more severe grades, incontinence of urine will be complete or partial, depending on the degree of maldevelopment of the sphincters.

The diagnosis is easily made by inspection, as the area is readily accessible to observation.

**Prognosis.** As incontinence is the usual complaint, the prognosis is good when the treatment is operative in type. Slight deformity, without incontinence, requires no treatment.

**Treatment.** Treatment is plastic surgery similar to that recommended for the relief of incontinence, with variations according to the local conditions found.

### *Hermaphroditism and Pseudohermaphroditism*

These anomalies are discussed on page 381.

## D PHYSIOLOGY OF THE FEMALE EXTERNAL GENITALIA

The physiology of the female external genitalia is concerned with the sexual act, and need not be described here.

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## CHAPTER XVII

### INJURIES AND DISEASES OF THE FEMALE EXTERNAL GENITALIA

#### A INJURIES OF THE FEMALE EXTERNAL GENITALIA

**Causes of Vulvar and Vaginal Injuries** Most injuries of the vulva and vagina are the result of external trauma, coitus, prolonged labor, or instrumental delivery

Labor, especially when instruments are used, is the most frequent and important cause of vulvar and vaginal injuries Hemorrhage is usually the chief symptom and may be very severe Fistulas, contractions and scars, or acquired stenosis or atresia of the vagina may result from the more severe injuries to these structures The gravest of these injuries and one with which surgeons have struggled for centuries, is vesicovaginal fistula

Injuries due to coitus range from the slight physiological rupture of the hymen to extensive tears involving the labia vestibule, and vaginal wall These result usually from rape abnormal practices immaturity, or senile involution

**Treatment** Slight lacerations require no treatment, but extensive tears need suturing under rigid aseptic precautions The repair of such injuries falls within the scope of the gynecologist and therefore will not be discussed here

#### B DISEASES OF THE FEMALE EXTERNAL GENITALIA

##### *1 Affections of the Vulva*

##### *Skin Diseases of the Vulva*

Certain of the skin diseases common to all integumentary regions may occur about the vulva Among the more common are pediculosis, scabies, psoriasis, eczema, impetigo contagiosa, epidermophyton in guinale, and herpes zoster Various forms of epidermomycoses and dermatomycosis due to deeper growing fungi (actinomycosis) are also seen

**Treatment** Treatment, in general, is the same as when these lesions

occur elsewhere on the body, except that the delicacy of the vulvar skin must be considered. These diseases are best studied in text books on dermatology.

### *Circulatory Disturbances*

**Edema** Edema may occur as part of a general anasarca due to heart or kidney disease, may be the result of local irritation from the rubbing of clothes or sanitary napkins, or may accompany infection or malignancy.

**Treatment** Treatment depends on satisfactory treatment or removal of the cause.

**Varicose Veins of the Vulva** Varicosities are most common during pregnancy or in multiparae. These may be unilateral or bilateral and take the form of convolutions of dilated veins in the vulva, varying in thickness from a few millimeters to a centimeter or more and held together loosely by connective tissue. Occasionally the swelling may be of such size as to simulate a real tumor.

The milder cases are usually symptomless, but in extensive varices there is an annoying dragging sensation, worse when the patient is up and about, and frequently associated with dermatitis. Rupture of a varix through direct violence, cough or effort, or trauma during labor may cause serious hemorrhage.

**Treatment** In cases severe enough to cause disturbance, the enlarged veins are exposed and tied off above and below, the intervening section being excised. The wound is closed with silk sutures.

**Thrombophlebitis** Thrombosis of the veins in the vulva is sometimes seen, and is usually due to injury of a small varicosity.

**Treatment** Rest in bed and hot compresses are usually all the treatment required. Evidences of swelling may, however, remain for some weeks.

### *Hydrocele*

**Hydrocele of the labium majorum** may occur in the region of the insertion of the round ligament in the upper part of the labium or it may occur in the peritoneal sac, which is formed in the canal of Nuck, and persist as a swelling in the labium (*congenital hydrocele*), or small swellings may occur (*sacular hydrocele*). Other types are *diffuse hydrocele*, in which there is serious infiltration into the connective tissue of the round ligament, and *hydrocele multibus interna*, which is a protrusion through an opening in Gimbernat's ligament.

**Treatment** Operative treatment is accomplished by exposing the sac

longitudinally, dissecting it free, and removing it—great care being taken to exclude hernia as a possibility. The bleeding vessels are tied off and the wound closed with silk sutures.

### *Inflammations of the Vulva (Vulvitis)*

The skin of the vulva is subject to the same inflammatory changes which may occur in the general body skin, but its structural peculiarities and exposure to genital discharges make it more susceptible to injury and infection. The vulval epidermis is often bathed by discharges coming from above (both normal and pathological), and, as a result, is usually moistened and softer than skin elsewhere.

Vulvitis may be acute or chronic, and is due to the invasion, by bacteria, parasites, or yeast forms, of vulval tissues whose vitality as a rule has been lowered by chemical or nutritional disturbances, mechanical irritation, or other debilitating factors.

The vulva of an adult is relatively resistant to infection, except in the urethra and Bartholinian ducts, unless the epithelium has been softened by discharges from the genital tract. In childhood, old age, the puerperium, and in debilitated conditions the epidermis is more vulnerable.

**Intertrigo.** This is common form of acute vulvitis and occurs most often in infants, fat women, the diabetic, and the uncleanly. It is due to maceration of the skin through excessive moisture. Accumulation of smegma under the clitoris may also produce a localized acute vulvitis.

The symptoms are diffuse redness of the skin, soreness, burning, and itching.

**Treatment.** Treatment consists of keeping the parts clean, dry, and exposed to the air, the irritation usually subsiding under these measures in a short time.

Adhesions about the clitoris should be separated and the parts carefully cleansed. Occasionally, circumcision may be necessary.

**Folliculitis.** Follicular vulvitis is usually an extension of intertrigo, the hair follicles of the vulva becoming infected. Small, red papules, later becoming pustules, are scattered over the surface of the vulva. The symptoms are more severe and lasting than those of intertrigo.

**Treatment.** Treatment consists of rest in bed, clipping the hair, cleansing the parts, and the application of an antiseptic such as metaphen. Ointments should be avoided. Heliotherapy in moderate doses is very useful in these cases.

**Furunculosis of the Vulva.** Furunculosis of the vulva is relatively

common, particularly in those subject to boils elsewhere in the body. The *Staphylococcus aureus* is the most frequent offending organism. The boils are found in the folds of the labia majora or about the mons veneris.

**Treatment** Treatment consists of rest in bed and hot compresses until the infected area forms a definite abscess, and then free incision where the boil is pointing.

**Erysipelas of the Vulva** Erysipelas, once a common aftermath of childbirth and operations on the vulva and vagina, has become very rare since the introduction of asepsis. When it does occur it is usually in association with puerperal sepsis, scarlet fever, or advanced carcinoma.

It starts with a severe chill and high fever, burning and itching in the vulva, with swelling and redness. Extension over the mons veneris and thigh is rapid.

**Treatment** Treatment is symptomatic, local applications being confined to compresses to relieve the pain and limit the spread of the inflammation.

**Puerperal Vulvitis** Puerperal vulvitis results from infection of lacerations and excoriations following childbirth. Streptococci produce sloughy ulcerous lesions that may remain localized and become gangrenous or may set up a bacteremia. Erysipelas may develop. Milder infections generally result from staphylococci, diphtheria bacilli, *Bacillus coli*, etc.

**Gangrenous Vulvitis** During the course of infectious diseases, particularly scarlet fever, or in severe puerperal infections there may be extensive necrosis and sloughing of the vulva, commonly in association with thrombosis. If the patient recovers, scarring and deformity result. This condition is now very rare.

Typhoid fever, smallpox, diphtheria, scarlet fever, dysentery and other infectious diseases may be accompanied by an associated vulvitis varying from a simple catarrhal inflammation to gangrene.

**Treatment** Treatment is that of the systemic infection with local applications to limit the spread of the disease and relieve the symptoms. In diphtheria, the treatment is antitoxin.

**Mycotic Vulvitis** Several kinds of fungi may cause this lesion, the best known being *Oridium albicans*, the organism which causes thrush. The lesions consist of elevated white patches reaching up to 1 cm. in diameter. They are rare in children but quite common in diabetics and the aged. The condition is difficult to cure. The vulvar infection may be accompanied by similar lesions elsewhere in the body.



**Inguinolabial Abscess** Inguinolabial abscess is caused by extension through the inguinal canal from pelvic infection

*Treatment* Treatment is incision and drainage

**Gonorrhea of the Vulva** Gonorrhea of the vulva without an associated vaginitis, may occur, particularly in young girls In such cases it is usually the result of an innocent contamination The infection is present in the urethral meatus the bartholinian glands, and the vestibule, and is evidenced by marked inflammation of the tissues and the presence of the usual profuse yellowish discharge

*Treatment* Treatment is discussed under Gonorrheal Urethritis (p 762)

### *Ulcerative Lesions of the Vulva*

**Tuberculosis of the Vulva** Tuberculosis of the vulva is very rare Primary tuberculosis of this region has never been demonstrated Most infections appear to be descending from the uterus and fallopian tubes, though a hematogenous origin and coital infection cannot be excluded

Two forms are recognized—an *ulcerative* and a *hypertrophic*, the former being much the more common Hypertrophic lesions may be difficult to distinguish from elephantiasis or lupus

Tuberculosis of the vulva is most common in young adults although it has been observed in a child of 2½ years and a woman of 75 years It may involve all the vulvar structures

*Treatment* Treatment with the Alpine light, combined with the usual constitutional measures for tuberculosis, gives the best results in the ulcerative cases

**Syphilis of the Vulva** The lesions of syphilis may appear on the vulva at any stage of the disease The *initial chancre* occurs as a button like infiltrated area, which may ulcerate It is commonly found on the inner surface of the labium majorum Other favorite sites are the vestibule, fourchette, and labium minorum Multiple primary lesions have been observed As the chancre is quite painless, it may escape detection which explains the entirely honest denial of many women, presenting secondary manifestations, that they have ever had an initial chancre

The inguinal glands on the affected side may become enlarged and hard *Spirochæta pallida* can be demonstrated in the secretions from the surface of the chancre, as well as from the tissue, by careful dark field examination

*Secondary lesions* may occur as (1) condylomata lata, broad papules sometimes covering the entire vulvar and perineo anal regions, or (2)

mucous patches upon the vestibular epithelium, particularly surrounding the vaginal orifice. These manifestations on the vulva are accompanied by the constitutional characteristics of this stage of syphilis: fever, enlargement of the lymph glands, and general skin eruption.

The condylomata lata are round or oblong ulcers which form flat plaques elevated slightly above the surface of the surrounding skin. They vary from pin point size to about 2 cm. in diameter, and are often confluent and widespread. Superficial ulceration may occur, and a profuse, highly infectious serous discharge containing the spirochete is secreted. They are easily distinguished from the sharp-tipped, clustering condylomata acuminata. The mucous patches are smaller, shallow ulcers with grayish bases, and resemble those found in the mouth.

*Tertiary syphilis* occurs as gummas which ulcerate and are very destructive. These involve both the vulva and vagina. There is usually some edema and hypertrophy, and the lesions may be difficult to distinguish from carcinoma, tuberculosis, elephantiasis, or esthiomene. Spirochetes are difficult to demonstrate.

*Treatment.* Treatment is systemic and consists in the administration of arsenicals and mercury or bismuth.

**Chancroid of the Vulva.** Chancroid is due to the activities of the Ducrey streptobacillus (see Diseases of the Penis, p. 261), which is implanted during coitus—the disease appearing within a few days after exposure. It is peculiarly a disease of unclean people and is therefore likely to be encountered only in the lowest class of women. It is much more common in Negroes than in whites. It occurs, in the female, in the form of multiple ulcers about the vulva. The typical lesion begins as a small papule, which rapidly becomes pustular and then ruptures, leaving a deep ulcer with a dirty yellow base and undermined edges. Smears from the serum show the typical bacillus of Ducrey. Chancroid is a strictly local affection except for secondary involvement of the inguinal glands, which takes the form of a painful swelling (bubo) that may break down and suppurate.

As chancroid is quite painful, it can thus be differentiated from syphilitic chancre, but the two may, and frequently do, coexist, and no treatment of chancroid should ever be instituted until after repeated dark field examinations.

*Treatment.* The treatment of chancroid in the female is essentially the same as in the male (Chancroid, p. 264).

**Granuloma Inguinale.** Granuloma inguinale may affect the vulva

as well as the inguinal regions and buttocks. The symptoms, signs, diagnosis, and treatment have already been described in the section on the male external genitalia. In the female, the labia majora suffer most. Once the external genitalia become involved, the entire vulvoperineal region is affected. The labia swell enormously and become almost elephantine.

*Treatment* Treatment is the same as in the male (Granuloma Inguinale, p. 280).

### *Condyloma Acuminata*

Condylomata acuminata are clusters of soft, sharp tipped, wart like excrescences appearing on the vulva, chiefly on the labia, but sometimes extending to the perineo anal region and thigh and into the vagina. They are associated with irritating vaginal discharges and, although commonest as a sequel to gonorrhea, are not necessarily venereal, since they may result from irritation of a non specific nature as well.

*Treatment* Treatment is excision with the high frequency loop.

### *Hypertrophic Lesions of the Vulva*

**Chronic Hypertrophic Vulvitis** Chronic hypertrophic vulvitis, first described by Huguier under the name of "esthiomene," practically always follows or is accompanied by a chronic ulcerative process, usually syphilitic. It may follow lymphogranuloma venereum. A high percentage of cases are in Negroes. The ulceration progresses slowly, resulting in widespread destruction of tissue, with hypertrophy, scar formation, and distortion. The condition must be differentiated from tropical elephantiasis, tuberculosis, and syphilis.

*Treatment* Treatment consists of curettage or cauterization of the ulcers and excision of nodular areas, followed by antiseptic dressings to prevent infection and hasten healing, which is always slow. Mercurochrome dressings are useful in these cases.

**Elephantiasis** True elephantiasis is a non contagious, chronic recurring inflammation found chiefly in the external genitalia, the extremities, and the mammary glands and producing an hypertrophy of the skin and subcutaneous tissue. It is a tropical and subtropical disease and is endemic in Malasia, China, India, Egypt, Arabia, and the tropics of America. It is due to lymphostasis produced by the embryo of the *Filaria sanguinis hominis* (Bancrofti), and is presumably transmitted by a certain species of mosquito (Elephantiasis of the Scrotum, p. 424).

*Elephantiasis vulvae* affects the labia, clitoris, or the entire vulva, the resulting tumors sometimes reaching great size. The acute stage of the disease, which usually lasts for a week or two, begins with fever and inflammation of the lymphatic glands. Edema and dilatation of the lymph vessels are fairly constant, but the epidermal changes are variable. Usually there are subsequent similar attacks, each one leaving the parts more hypertrophied. The skin may be smooth, nodular, or warty.

Tuberculosis, syphilis, and chronic hypertrophic vulvitis must be ruled out. All of these may produce lesions that, clinically, may be difficult to differentiate from elephantiasis.

The prognosis as to curability is unfavorable, although the disease seldom shortens life.

*Treatment.* Excision of the affected part, if possible, is advisable in cases of marked hypertrophy. In the acute stage, local soothing applications are useful.

#### *Atrophic Lesions of the Vulva*

*Kraurosis.* Simple kraurosis of the vulva is a chronic atrophy affecting the labia minora, vestibule, clitoris, and urethra. Although most common after the menopause, the disease has also been observed in the young. The etiology is obscure.

In early stages of the disease there is extreme sensitivity of the parts. Later the soreness and itching disappear, the urethra usually becomes distorted, and dyspareunia occurs from contraction of the vaginal orifice and narrowing of the canal due to thickening of the subepithelial tissues. In advanced cases there may be almost complete disappearance of the labia minora and but slight traces of the clitoris.

*Treatment.* The condition can generally be controlled by the use of estrin, either locally, as an ointment, or by injection.

*Leukoplakia of the Vulva.* Leukoplakic vulvitis is a chronic atrophic, inflammatory condition characterized by the formation of white plaques of thickened, parchment like tissue on the labia majora or other parts of the vulva, with sclerosis of the surrounding tissue. It results from prolonged irritation in this region. Pronounced itching is an almost invariable symptom. Less frequently there is burning, especially on urination, and dyspareunia.

*Treatment.* Because the lesion favors the development of malignancy, treatment is surgical excision. Roentgen rays and radium are less satisfactory but are sometimes useful when surgery is contraindicated.

Endocrine therapy and local applications for relief of the itching have been found of little value

**Vitiligo** Vitiligo is a depigmentation of the skin of unknown origin, and is characterized by the development of circumscribed areas of whitish patches with deeper pigmentation in the surrounding skin. These areas may occur about the vulva, although the condition is uncommon. They do not cause symptoms and cannot be cured.

### *Pruritus Vulvae*

Pruritus vulvae, or chronic itching of the vulva, is of common occurrence. The cause may be entirely of nervous origin, or associated with systemic disease such as jaundice, or the itching may accompany any form of vulvitis, hemorrhoids, worms, abnormal vaginal discharges, vermin, or any condition causing congestion of the parts. Sclerosis affecting terminal nerve endings is also a cause.

The pruritus may extend all over the genital region, but the clitoris and labia are the areas most commonly affected. The skin takes on a grayish leathery appearance. Excoriations are usually present from the scratching. Microscopically, changes in the nerve terminals can be made out. The itching may be constant or paroxysmal, is worse at night, and may be so severe as to affect the health of the patient.

**Treatment** Treatment consists of local applications of anesthetic lotions and ointments, bromides by mouth, radiotherapy, partial vulvectomy if the pruritus is limited to the area about the clitoris and labia minora and fails to respond to treatment, and general measures, such as sitz baths, regulation of diet, and elimination of the causative factors.

An excellent ointment for the relief of this condition is nupercaine ointment (1 per cent).

### *Benign Tumors of the Vulva*

**Cysts of the Vulva** Cysts are not infrequently found in this region. The majority are small, simple retention cysts, but some reach considerable dimensions, and multilocular cysts are occasionally observed. Sebaceous cysts and dermoids sometimes occur on the labia, and mucoid cysts may result from closure of the mucoid glands, particularly in the vestibule.

Retention cysts of the Bartholinian glands are the most common cysts of the vulva. They result from closure of the duct after inflammation—commonly, but not necessarily, gonorrheal. These cysts are often bi-

lateral, and may reach a considerable size. Suppuration and abscess-formation may take place as an acute or chronic process. The suppuration may extend into the surrounding tissues and in rare cases may result in perineal or rectal fistulas. In the acute condition there is fever, local congestion, and pain, with painful urination. Fluctuation can sometimes be detected.

*Treatment* Treatment, except in acute cases, is surgical excision. Acute conditions are treated by hot applications until the inflammation is localized, when the abscess should be incised and drained. Later the affected gland is removed.

**Lipoma** Lipomas of the vulva are infrequent, and usually occur in the labia majora or mons veneris. They may be sessile or pedunculated, and may reach a considerable size—one tumor of 44 pounds having been reported (Lovelace).

*Treatment* Treatment is surgical excision, which is generally quite easy with the smaller pedunculated tumors, but may present considerable difficulty when the growth is a large one.

**Fibroma Fibromyoma Adenomyoma** Any of these tumors may develop on the vulva, but their occurrence is uncommon. Fibromas and fibromyomas may reach great size.

*Treatment* Treatment is surgical excision.

### *Malignant Tumors of the Vulva*

**Carcinoma** Primary carcinoma of the vulva, while uncommon, occurs sufficiently often to be of clinical importance. It is exceedingly malignant, and is most common in women over 50 years of age. The sites of occurrence, in order of frequency, are the labia majora or interlabial fold, the clitoris, the labia minora, other parts of the vulva and, rarely, the glands and ducts of Bartholin.

Pruritus, kraurosis, and especially, leukoplakia in many instances appear to precede and to favor the development of cancer. Carcinomas occurring on the sites of other lesions such as a gumma, an x ray burn or the base of a condyloma acuminata have also been described.

Starting as a wart like nodule, usually at the site of some previous irritation, the growth develops most commonly as an indurated ulcer, although cauliflower like growths are also seen. Extensive infiltration of paraurethral and paravaginal tissue and early involvement of the inguinal lymph nodes are the rule. The majority of vulvar carcinomas are of the squamous-cell type. Adenocarcinoma occurs sometimes in the

bartholinian glands and other glandular structures about the external genitalia

Metastatic carcinoma of the vulva is not uncommon, the primary focus being in the uterus or ovary

The chief early symptom is pruritus. Pain, hemorrhage, and urinary symptoms due to urethral involvement are late manifestations

The diagnosis is made upon microscopic examination of a biopsy specimen. Other lesions that may cause confusion are tuberculosis, elephantiasis, syphilis, chancroid, granuloma inguinale, and condyloma

*Prognosis* The prognosis in carcinoma of the vulva is not encouraging. Recurrence after operation is common. It has been estimated that cure is possible in from 30 to 50 per cent of cases if radical removal of the primary growth and lymph nodes is done

*Treatment* The treatment is radical surgical removal of the growth and the involved nodes. The type of operation must depend on the extent and location of the tumor. Inoperable cases are treated by radium and roentgen rays. Radiation is also used for treatment of the inguinal nodes (Radiation of the Female External Genitalia, p. 1739)

*Sarcoma Melanoma* Sarcoma and melanoma of the vulva are very rare. Their tendency to widespread metastases gives them an almost hopeless outlook

### *Diseases of the Vulvae of Children*

*Noma Vulvae* Noma vulvae is a usually fatal gangrenous vulvitis occurring chiefly in young debilitated children, particularly in those living in institutions. Beginning as a localized furuncle on the labium, it rapidly develops into a widespread ulcerative process accompanied by marked constitutional symptoms

*Gonorrheal Vulvovaginitis* Gonorrheal vulvovaginitis in children is relatively common, particularly among the dispensary group of patients. Epidemics occur in institutions. The contagion is spread by contact with contaminated toilet seats, towels, sponges, and other articles. Not infrequently children acquire the infection from sleeping with infected parents

Female children are peculiarly susceptible to gonorrhea. The delicate columnar epithelium of the child is much less resistant to the gonococcus than the squamous epithelium of the adult

*Symptoms and Diagnosis* The initial complaint is usually of itching and burning about the genitals, a purulent, malodorous discharge, and

frequency of urination. Examination will disclose the labia swollen, intensely red and glued together by a sticky exudate which may be thick and purulent or merely a thin watery discharge. As a rule the urethra and cervix are also involved in the acute stage. The cervix is swollen and hyperemic.

The gonococcus can be recovered from urethral and vaginal smears in the early stage.

*Treatment* Before the introduction of sulfanilamide and its derivatives the treatment of gonorrhea in female children presented a very serious medical problem because of the extreme delicacy of the structures involved and the difficulty of obtaining the cooperation of the young patients. It was seldom cured short of months (and even years) of intensive treatment.

Children appear to tolerate the sulfonamide drugs extremely well as compared with adults. Sulfadiazine is preferred to the older sulfanilamide and sulfapyridine for the treatment of gonorrhea. The dosage is 30 mgm per pound of body weight daily in divided doses. Treatment is usually continued for from 5 to 10 days the patient being carefully observed for possible toxic reactions. If necessary a second course of similar dosage and duration may be given after a rest period of a week or 10 days.

A method of treating gonorrheal vulvovaginitis in immature girls that has had considerable success is the administration of the female sex hormone (theelin, progynon, amniotin) obtained from the urine of pregnant women. This is available in aqueous solution or oil for intramuscular administration in capsules for oral use and in suppositories for vaginal use. The administration of the estrous hormones to immature females results in a proliferation of the layers of the vaginal mucous membrane and the production of an almost adult type of mucosa. With adequate dosage of the estrogenic substance the surface epithelium becomes somewhat cornified and more resistant to the rapidly growing gonococci. After several injections at regular intervals the profuse purulent vaginal discharge common in these cases either disappears almost entirely or changes to a milky white leukorrhea which subsequently disappears. There is also a marked decrease in the intracellular and extracellular gram negative diplococci and an increase in gram positive bacilli and other organisms and in epithelial cells.

We have obtained the best results by the use of large doses (2 000 or more units daily) of amniotin injected intramuscularly in conjunction



with external hygiene of the parts and sitz baths. Good results have also been obtained with theelin in oil. Occasionally the intramuscular injections are used in conjunction with the suppositories. Usually the smears and cultures become negative in about 4 to 6 weeks. The total number of injections and the total number of units of estrogenic sub

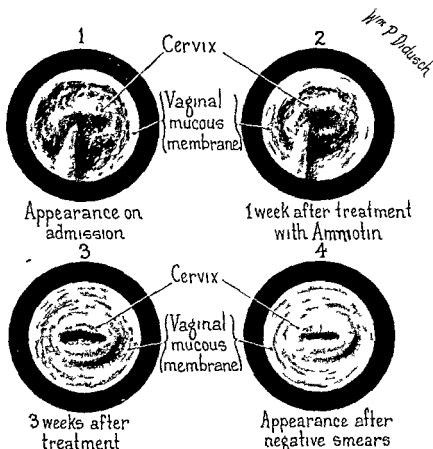


FIG 117 Gonorrheal vaginitis in a 4 year-old girl. Showing the appearance of the cervix and vagina before and after treatment with ammotin. (Courtesy of Dr. Rose André Vaginitis Clinic, New York Hospital)

stance vary considerably with different patients. It has been our experience that larger doses over a longer period will produce more lasting cures and insure against recurrence. Thus far we have found no evidence of harmful results even in cases where large doses have been administered over long periods.

The results of treatment are followed by external and internal examination as well as bacteriologically and serologically. The appear

ance of the mucous membrane and cervix is observed through the vaginoscope and smears cultures and complement fixation carefully watched. Patients are followed up for periods varying from 1 to 2 years. If during the follow up period the discharge returns or if a smear or culture becomes positive an additional course of injections is given.

When there is a copious purulent discharge vaginal irrigations may be added at the beginning of treatment and continued until the hormonal treatment becomes effective. Satisfactory solutions for irrigation are boric acid 2 per cent, sodium bicarbonate 2 per cent, or potassium permanganate 1:5000 or 1:10000. In the smaller children irrigations are given through a No. 14, 16 or 18 French catheter.

Boric acid ointment 2 per cent may be applied to counteract irritation.

Fulguration of the diseased cervical and vaginal glands is occasionally necessary. An excellent instrument for this purpose is the Butterfield urethroscope (Fig. 3) which has proved of great value in locating the diseased glands.

## 2 Affections of the Vagina

### *Vaginitis*

Vaginitis or inflammation of the vaginal canal is caused by bacteria, parasites or fungi. It may be acute, subacute or chronic.

**Etiology.** The vaginal mucosa is less resistant in young girls and old women than in the normal healthy adult in whom the vaginal epithelium is very resistant to infection. On the other hand the period of sexual activity exposes the vagina to increased dangers of infection and trauma and the various forms of vaginitis are most apt to occur during this period.

The vaginal epithelium may be impaired through coitus, instruments, operations, douche tips, chemical irritants, pessaries and other foreign bodies. Infection may be carried from the anus especially in diarrhea or from the bladder in cystitis. Irritating discharges from the cervix or pelvic organs above are conducive to acute or chronic vaginitis. Menstrual discharges by reducing the normal acidity of the vaginal secretion favor the growth of bacteria. Certain acute infectious diseases may be accompanied by involvement of the vagina and chronic diseases such as diabetes and the anemias may lower the resistance of the vaginal mucosa.

The causative agent is some microorganism, parasite or fungus. Gonorrheal vulvovaginal infections are common in children but in the

healthy adult the gonococcus will not primarily attack the vaginal mucosa. A gonorrheal vaginitis may, however, develop secondarily from infection elsewhere. Given favorable conditions any pathogenic organism may set up a vaginitis. Various fungi, such as *Oidium albicans* and certain moniliae may cause severe vaginitis. *Trichomonas vaginalis* frequently produces vaginitis, although this organism is found in many vaginal secretions examined, without producing symptoms.

The gonorrheal vulvovaginitis of children is discussed elsewhere (p 591)

**Pathology** The following classifications of vaginitis are recognized: catarrhal, granular, erosive, membranous, necrotic, gangrenous, exfoliative, ulcerative, adhesive and emphysematous. The same cause may produce mild or severe types of inflammation, depending upon the virulence of the microorganisms, the local conditions present, and the resistance of the patient.

**Signs Symptoms Diagnosis** Acute vaginitis manifests itself by heat and pain, pruritus, dyspareunia, and a leukorrheal discharge which varies according to the exciting cause. In the chronic cases the irritating discharge, pruritus and pain on coitus are usually the chief complaints.

**Examination** reveals a congested vaginal wall with discharge. The appearance of the vaginal mucosa varies considerably with the degree and type of infection present. In the granular form, hypertrophied papillae are sometimes felt. In thrush characteristic white patches are present. The vaginitis associated with *Trichomonas vaginalis* has a strawberry like appearance and is most marked in the posterior fornix. Senile vaginitis is usually accompanied by some erosion of the atrophic epithelium and in long standing cases the fornices may be obliterated by adhesions. Vegetations are sometimes seen, particularly in gonorrheal vaginitis.

**Diagnosis** is made by palpation, inspection through the speculum, and by staining and cultures of the discharge or biopsy of suspected areas.

**Prognosis** Since most of the exciting causes respond to appropriate treatment, vaginitis is usually curable, providing the cause can be determined and removed. Occasionally, as in inoperable cancer, cure is impossible and treatment is only palliative. In very severe cases, destruction of tissue may result in more or less scarring and atresia.

**Treatment** Cleanliness is the first essential in both treatment and prevention. Douches should consist of warm (never hot) mild antiseptic solutions administered through a sterile douche tip. Treatment

of acute vaginitis consists of rest in bed absolute cleanliness of the parts, simple diet and avoidance of constipation by the use of mild laxatives. After cleansing the external genitalia they may be painted with a mild antiseptic, such as tincture of metaphen. Strong irritating antiseptics are contraindicated. When the acute inflammation subsides, mild antiseptics may be introduced into the vaginal canal, the choice of antiseptic depending upon the type of bacterium found to be present. The cause of the vaginitis should always be sought as soon as the acute stage has subsided, and eradicated if possible. Removal of the cause usually results in prompt healing of the vaginal mucosa, with restoration to normal conditions except in very severe cases when scarring and atresia may follow healing.

The treatment of gonorrheal vulvovaginitis in immature girls by the administration of theelin has already been discussed (p. 592). It has been noted by several investigators that any vaginal infection—gonorrheal or non specific—is benefited by the artificial maturing of the vaginal mucosa thus produced.

A method of treatment of *Trichomonas vaginalis* infection that has had considerable success is the following: (1) Wash the cervix and vagina with tincture of green soap and dry. (2) swab the cervix, vagina and vestibule with pyroligneous acid, full strength. (3) fill the vagina with powdered kaolin or talcum.

### *Tuberculosis of the Vagina*

Tuberculosis of the vagina is rare though more common than that of the vulva, and is usually secondary to lesions of the uterus, cervix, tubes, ovaries, bladder, or rectum. Hematogenous infection is uncommon. The lesion is usually found near the cervix. The most common form is the typical tuberculous ulcer, with serpiginous edges and base covered with caseous degeneration and granulations. The miliary form is rarer. Vesicovaginal or rectovaginal fistulas may develop. The histological picture is similar to that of tuberculosis elsewhere.

The condition must be differentiated from carcinoma and syphilis which usually is not difficult.

*Treatment.* Applications of pyroligneous or lactic acid to the ulcers sometimes promotes healing. The application of the Alpine light with the Lowsley Wang applicator is very helpful. The general hygienic measures employed in combating tuberculous infection (p. 1196) are most important. If the vaginal infection is secondary to tuberculosis of the ovaries and tubes, their removal is indicated.

### *Syphilis of the Vagina*

Syphilis of the vagina is uncommon and has received scant consideration in the literature. Any stage of the disease may, however, manifest itself in this location. The primary chancre has been observed very infrequently, Schroeder and Kuhlmann (1921) finding only 47 cases in the literature. Since the chancre is usually painless it may easily be overlooked, which may account for the rarity of its observation. Secondary lesions—macules, papules and condylomata lata—are more commonly seen. Tertiary lesions are usually due to extensions from the vulva and generally result in fistulas and stenoses.

The diagnosis and treatment are the same as for syphilis elsewhere, and have already been described.

### *Chancroid of the Vagina*

Chancroid of the vagina is usually an extension of chancroidal infection of the vulva, and is diagnosed and treated in a similar manner. As with chancroid of the vulva, the disease here may coexist with syphilitic chancre.

### *Lymphogranuloma Venereum*

The course of lymphogranuloma venereum in the female differs from that in the male (Lymphogranuloma Venereum, p. 280). The primary lesion is usually on the posterior fornix or cervix and very rarely on the external genitals. Being hidden it is overlooked. Lymphatic drainage from these parts causes involvement of the deep pelvic lymphatics. In only a very small proportion of females is the adenopathy localized in the inguinal or inguino-crural group of nodes where it is readily observable. In the majority of cases localization is in the intrapelvic nodes and connective tissue. Late sequelae, such as stricture of the rectum and the condition variously described as chronic elephantiasis or esthiomene of the vulva or chronic hypertrophic or ulcerative vulvitis, are usually the first intimation of infection with this disease in the female. As a rule, this type of rectal stricture is located high up in both men and women. A high rectal stricture in a woman should always suggest the possibility of a previous lymphogranuloma venereum infection, demanding the application of the Frei test.

### *Condyloma Acuminata*

Condylomata acuminata are usually found on the vulva, but may extend into the vagina. They are not infrequent in pregnancy. The

sondation results from irritating discharges, usually but not necessarily gonorrheal, and is more common in persons of unclean habits

*Treatment* Treatment is excision with the high frequency loop

### *Vaginismus*

Vaginismus is a painful spasmodic contraction and hyperesthesia of the vagina, preventing the introduction of anything into the canal. It may be due to a variety of causes—a sensitive, unruptured hymen or sensitive carunculae hymenales, vulvar or anal fissures, urethral caruncle, or prolapse. Sometimes no apparent irritative cause can be found.

*Treatment* Treatment consists of removal of the local source of irritation, which usually necessitates operative intervention. As this condition is commonly found in young nervous women, general measures to build up the health are advisable.

### *Acquired Stenosis and Atresia of the Vagina*

Acquired stenoses and atresias of the vagina are the result of injuries or inflammations occurring in postnatal life. Injuries may occur during labor, or from the use of caustics or too hot douches, or may be due to radium burns. Infection is a frequent cause.

*Treatment* Treatment is usually surgical. In some cases the septum may be cut and the vagina dilated. In others plastic surgery, varying with the condition present, is necessary. These procedures fall properly within the scope of the gynecologist.

### *Benign Tumors of the Vagina*

**Vaginal Cysts** Vaginal cysts are of fairly frequent occurrence. They may be congenital, but are more frequently the result of inflammatory changes or trauma. They are usually discovered by accident unless they are of unusual size or interfere with coitus. The cysts are commonly unilocular and of small size, but cysts reaching the dimensions of a coconut have been reported. Multilocular and dermoid cysts are very rare. *Crops of small cysts, scattered over the vaginal mucosa and resulting from inflammatory changes, have been described.*

Small cysts cause few or no symptoms. Larger ones obstruct the vagina and may produce a leukorrheal discharge.

*Treatment* As complete surgical excision as possible is indicated in those cases producing symptoms.

**Mucous Polyps** Mucous polyps are occasionally seen in the vagina,

usually on the posterior wall They must be differentiated from malignant growths

*Treatment* Treatment is excision with the cautery knife

**Fibroma· Fibromyoma: Adenomyoma· Lipoma** Fibroma, fibromyoma, and adenomyoma are uncommon, the majority of these tumors being fibromyomas akin to those found in the uterus They may occur in any part of the vaginal canal, although the most common site is the anterior wall They may be either sessile or polypoid and are usually well encapsulated Ulceration frequently occurs, in which event the condition may be mistaken for malignancy

Lipomas are very rare and have been described in the literature in only a few instances

Small tumors are usually symptomless The larger ones give a sensation of weight and may interfere with coitus and cause urinary disturbances by pressure Leukorrhea may be present

*Treatment* Treatment is complete surgical removal, if possible, great care being taken to avoid injury to adjacent structures

### *Malignant Tumors of the Vagina*

Malignant tumors found in the vagina are carcinoma, sarcoma, chori-  
onepithelioma, and hypernephroma—the last metastatic

**Carcinoma** Carcinoma of the vagina is infrequent Primary growths are very rare, the condition usually being an extension of contiguous lesions in the cervix or metastasis from the uterus, ovaries, bladder, or other organs The most common location of primary carcinoma of the vagina is in the posterior fornix, whence the process extends upward rapidly, producing early involvement of the cervix and sometimes of the rectum or bladder, in which case it may be impossible to determine the original location of the growth According to Ewing, the initial lesion appears as a wart like growth, a superficial nodule, or a diffuse infiltration Later on, the chief types are (1) a circumscribed, granular, ulcerated area with indurated edges, (2) a diffuse carcinomatous infiltration, which extends rapidly and converts the vagina into a rigid tube obstructed by projecting nodules

The diagnosis is based on histological examination of a biopsy specimen

*Treatment* Treatment is unsatisfactory Complete surgical excision is indicated, if possible, followed by treatment with roentgen rays or radium Inoperable cases are treated with radium or x ray therapy (Radiation of the Female External Genitalia p 1739)

**Sarcoma Chorionepithelioma** Sarcoma of the vagina is also uncommon and is found most frequently in childhood or occasionally at birth. Sarcomas occurring in adults usually originate in the lower part of the vagina although they may occur in any portion of the canal. Metastatic vaginal sarcomas from uterine primary growths have been reported. Melanosarcomas are extremely rare. Sarcoma of the vagina must be differentiated from sloughing benign tumors, cysts, and carcinoma. As with sarcoma elsewhere, the prognosis is poor. Metastases usually appear late, but rapid recurrence after local removal is the rule.

A few cases of primary chorionepithelioma of the vaginal wall, histologically similar to chorionepithelioma of the uterus, have been reported. Usually, however, the vaginal growth is secondary to uterine involvement. The condition is rare.

**Treatment** Treatment is the same as for carcinoma. Radium and deep x-ray are particularly useful in the treatment of chorionepithelioma in the female, as in the male.

### 3 Affections of the Hymen

**Acquired atresia** of the hymen, due to inflammatory changes, is a common condition. **Rigid hymen** is also common and may cause vaginismus, dyspareunia, or even prevention of coitus. Surgical intervention—incision or possibly excision—is usually necessary.

**Elastic hymen** may permit coitus and even labor without rupture.

**Unusual vascularity** of the hymen may cause severe hemorrhage when it is ruptured.

**Cysts** of the hymen are uncommon, usually congenital, and of varied derivation. They are most often found on the outer edge. Treatment is excision.

**Inflammation** of the hymen frequently occurs, as this structure may partake in any type of inflammation originating in the vulva or vagina. It may also be affected primarily.

**Benign and malignant tumors** of the hymen may occur, but have been reported in but few instances.

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## CHAPTER XVIII

### OPERATIVE TREATMENT OF THE FEMALE EXTERNAL GENITALIA

#### *Preoperative Preparation*

The usual precautions as to purgation, light diet, and forcing of fluids are carefully observed. Sedatives should be given the night before operation, to insure a good night's sleep, and again one hour before operation.

#### *Anesthesia*

The anesthesia preferred by us for operations upon the female external genitalia is spinal anesthesia.

#### *Circumcision*

**Indications** Circumcision is sometimes necessary when the clitoris is hooded, thus interfering with sexual feeling and efficiency, or causing retention of secretions and desquamated epithelium and the formation of smegma, such as is seen in the male under similar conditions.

**Technic** A dorsal incision is made, sufficiently long to expose the glans of the clitoris. The hood is then separated from the glans to the corona and the excess tissue excised. The cut edges are sutured, bleeding points having been clamped and ligated, and the wound dressed with sterile vaseline gauze.

#### *Clitoridectomy*

**Indications** Excision of the clitoris is indicated in the presence of malignant growths, cysts, benign growths, elephantiasis, and other rare conditions.

**Technic** The skin is incised across the dorsum of the clitoris and the incision carried around the base of the organ. The clitoris is then excised, bleeding points tied off, and the wound closed in layers.

In carcinoma a more radical procedure is necessary.

*Extirpation of Bartholin's Glands*

**Indications** Removal of Bartholin's glands is recommended in cases of cystic degeneration or chronic inflammatory disease

Incision and drainage of acute fluctuating abscesses is sometimes necessary as a preliminary to complete removal

**Technic** An incision is made through the skin between the labium minorum and the labium majorum The incision should be wide enough to include all of the structure, the duct being removed last to prevent spilling of the contained pus Bleeding vessels are carefully ligated and the wound closed with drainage

*Vulvectomy*

**Indications** The circumstances under which vulvectomy or partial vulvectomy may be necessary have been mentioned in the preceding pages

**Technic** Excision of the vulva is accomplished by making incisions outside the vulva and within it The vulva is then removed, bleeding vessels ligated, and the skin edges approximated

In *partial vulvectomy* the extent of the incision and removal is determined by the conditions present

*Operative Treatment of Hypospadias in the Female*

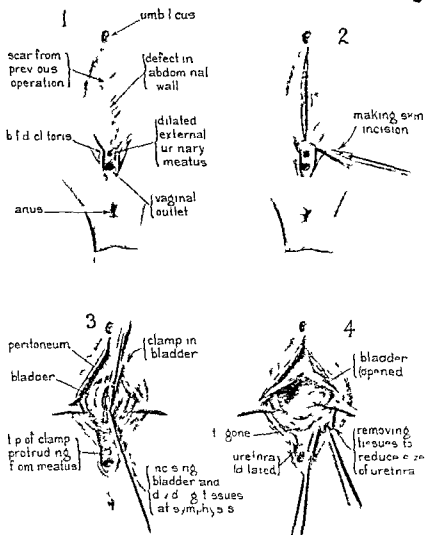
The milder grades of hypospadias with no disturbance of urination, do not require treatment In cases of obstruction, relief may sometimes be obtained by simple dilatation of the urethral meatus Incision is occasionally necessary and in some cases an internal urethrotomy may be indicated

Incontinence is treated by plication of the urethra with ribbon gut, as described by Lowsley (p 1140) by muscle transplants, or, in extreme cases, such as those in which the bladder opens into the vagina, by implantation of the ureters into the bowel

*Operative Treatment of Epispadias in the Female*

In epispadias with incontinence the constant leakage of urine may sometimes be relieved by plication of the urethra with ribbon gut (p 1140) In other cases removal of the roof of the urethra and a wedge shaped section of the bladder neck, and reconstruction of the urethra over a No 10 French catheter, with suprapubic counterdrainage will effect

relief (Figs 118 and 119) In extreme cases, the ureters must be transplanted to the bowel

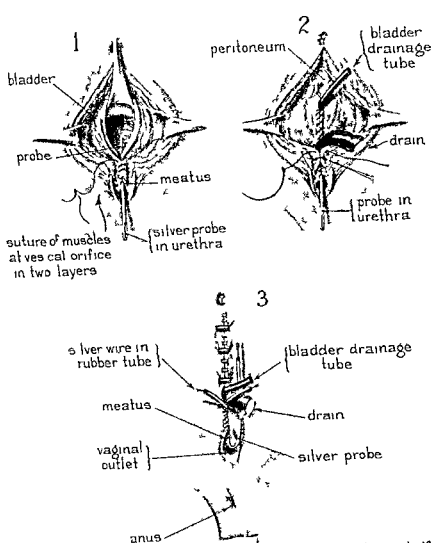


W. J. O. Oct 1932

FIG 118 Operation for epispadia with incontinence in the female (1) Shows the condition bifid clitoris dilated external urinary meatus and vaginal outlet (2) A longitudinal suprapubic incision is made through the scar of a previous operation and dissection carried around the urethra and to the side of the vagina (3) The bladder is incised down to and into the urethra (4) A wedge shaped section of the vesical neck is excised to reduce the size of the urethra

*Postoperative Care*

**Immediate Postoperative Care** It is very important to protect the patient from cold, dehydration, and pain. The patient should be kept



Wm P Didusch 1932

**FIG 119** Operation for epispadias with incontinence in the female (1) The urethra is sutured tightly over a small probe (2) The bladder is closed with a drainage tube left in position and a Penrose drain down to the prevesical space (3) Final closure showing the bladder drainage tube and a silver probe in the urethra

well covered and supplied with artificial heat in the form of hot water bags or a carefully adjusted electric pad. If she has had spinal anesthe-

sia, her head must be kept lowered for about 8 hours. Fluids must be administered by mouth, rectum, or vein, as indicated. Pain is prevented by one of the barbiturates or morphine derivatives.

Pulse, temperature, and blood pressure are carefully followed and charted. Blood counts are made, if indicated. The patient is given a suitable diet as soon as recovery from the anesthesia permits. The bowels should be encouraged to move on the third day.

Dressings are changed frequently and drains removed when their purpose has been served.

**Postoperative Complications.** Bleeding and thrombosis are the real enemies of the surgeon and next in order is abdominal distention. These, however, are infrequent complications in operations upon the female external genitalia.

## CHAPTER XIX

### EMBRYOLOGY, ANATOMY, ANOMALIES, AND PHYSIOLOGY OF THE MALE URETHRA

#### A EMBRYOLOGY OF THE MALE URETHRA

**Development of the Urogenital Sinus** In young embryos the hind-gut and the allantois unite in a common *cloaca*, the ventral wall of which is formed in part by the *cloacal membrane*. In an embryo 5.3 mm long the primitive cloaca divides into two parts the *dorsal rectum* and the ventral *urogenital sinus*. This division is completed during the seventh week, when the *urorectal septum* extends to and fuses with the cloacal membrane, separating the latter into the *anal membrane* and the *urogenital membrane*. Subsequently (between 13 and 18 mm) both of these membranes break through, thereby forming the anal and urogenital openings.

When the embryo is between 7 and 11 mm long, the urogenital sinus, by a process of elongation and constriction, divides into two portions (1) a dorsal *vesico-urethral anlage*, which is continuous with the allantois, (2) the ventral segment, the *pars phallica of the urogenital sinus*, which is connected with the vesico urethral anlage by a narrow neck, the *pars pelvina of the urogenital sinus*, and is floored by the urogenital membrane. From the first division, which enlarges and receives the mesonephric ducts, is formed the urinary bladder and a portion of the urethra. The phallic segment extends into the genital tubercle of both sexes, developing into the cavernous urethra in the male but merging with the vestibule in the female.

**Development of the Penile Urethra** The development of the penile urethra has already been touched upon in connection with the embryology of the penis (p. 223). To resume briefly. The genital tubercle appears in an embryo of 8 mm as a rounded eminence occupying the midline of the ventral body wall between the umbilical cord and the tail. By the end of the seventh week (17 to 20 mm) it has elongated into a cylindrical phallus bearing at its tip the rounded glans, which is separated from the shaft by a groove, the *coronary sulcus*. The urogenital sinus, as we have seen, extends out into the phallus on its anal slope.

In the embryo 26 mm long the urogenital sinus extends from Muller's tubercle to the tip of the phallus. The pars pelvina undergoes active growth at its base and forms part of the prostatic urethra. The more passive pars phallica remains hollow in its proximal portion but in the glans becomes a solid urethral plate. When the embryo is between 13 and 18 mm long the hollow portion of the urogenital sinus opens through to the exterior by splitting of the urogenital membrane to form the trough like *primitive urogenital opening* the slightly elevated margins of which are known as the *urethral folds*.

*Closure of Urethral Groove* With the subsequent great elongation of the male phallus the open portion of the urogenital sinus is also lengthened and forms the greater part of the penile urethra. During this process of elongation, and starting when the embryo is about 68 mm long the edges of the urethral groove progressively fuse from the basal end thereby transforming the open urogenital sinus into the tubular urethra. The fusion of these folds forms the *perineo penile raphe*. By the fourteenth week the urethra has closed as far as the glans. (Felix disagrees with the foregoing explanation of the manner in which the primitive urethral orifice is carried up to the coronary sulcus and contends that the opening is carried distally by basal growth rather than by fusion of the urethral folds.)

The process which results in the closure of the genital groove is a mesoblastic activity spreading along the penis affecting especially the lips of the urethral groove and being a direct extension of the process which results in the formation and union of the lateral fold of the entodermal cloaca (Spicer). The two small projections upon the caudal boundary of that transverse slit which represents the opening of the common cloaca meet at the midline by a process of gradual incurving and following this the lips of the primitive urogenital opening immediately in front are drawn together and united. From this point forward to the base of the glans a similar activity prevails the lips of the urethral groove elongate thicken converge and ultimately unite in the midline to form the floor of the cavernous urethra. The activity spreads rapidly along the penis until the groove is converted into one continuous tube lined by epithelium from the bladder to the base of the glans.

*Development of Urethra Within the Glans* Finally at 105 mm the solid urethral plate of the glans splits forms a trough to the tip of the glans which in turn closes into a tube from behind forward. The urethra is thereby continued to its permanent opening at the tip of the



glans During this process, the primitive urogenital opening is completely closed

*Corpora Cavernosa and Corpus Spongiosum* The corpora cavernosa arise as paired mesenchymal columns within the penile shaft The unpaired corpus spongiosum urethrae results from the adherence of similar mesenchymal masses, one in the glans and the other in the body of the shaft

*Development of the Verumontanum* The verumontanum begins to develop, from Muller's tubercle, about the fourteenth week of fetal life, at which time it is indicated only by this rounded elevation on the mid ventral floor of the urogenital sinus, the presence of which is due to the upward growth of the ejaculatory ducts At about the same period, there is also found here a closed sac like cavity, the future *prostatic utricle*, or *sinus parularis*

*Formation of the Tubules* Watson's investigations show that between the fourteenth and twenty fifth weeks of fetal life three sets of glandular tubules form The first group, which appear at the periphery of the verumontanum at about the fourteenth week, have their origin in the invaginations of the mucous covering, and communicate with the posterior urethra Two weeks later a second group of tubules has appeared These arise in the suburethral portion of the middle lobe of the prostate and lie just below the outer stratum of the tubules previously formed, communicating with the urethra at about the middle third of the verumontanum The pushing upward of these tubules toward the collicular prominence is due, partly at least to the upward slanting course of the ejaculatory ducts At about the twenty fifth week a third group of tubules having their origin in the utricle appear They are found largely in the anterior portion of the utricle, their starting point being an invagination of the wall of the prostatic urethra

These three sets of tubules can be plainly identified by the thirty first week At this period the prostatic utricle will be found to communicate with the prostatic urethra by an opening at the summit of the verumontanum A well developed stroma similar to that of the prostate is now discernible between the tubules enclosing and supporting all the glandular elements of the colliculus seminalis

Thus, at birth the first group of tubules originating in the mucous membrane, are found in the upper third near the internal sphincter of the bladder, lying parallel to the urethral floor, with their blind ends pointing backward toward the bladder and all opening through the sides

or top of the verumontanum into the prostatic urethra. The second group, arising in the prostatic region, occupy the middle third of the organ, their blind ends well within the deeper tissue but lying in an upward and outward direction so that their orifices open along the sides of the verumontanum or, occasionally, in front of those of the utricle or ejaculatory ducts. The third group, arising from the periphery, are found at birth practically parallel to the urethral floor, their blind ends toward the internal vesical sphincter and their terminations in an orifice communicating with the cavity of the prostatic utricle.

## B ANATOMY OF THE MALE URETHRA

The urethra in the male is a membranous canal extending from the neck of the bladder to the tip of the glans penis, where it terminates in the urethral meatus. It serves for the passage of both urine and seminal fluid.

It is subdivided into three portions: the *prostatic*, the *membranous*, and the *spongy*. The prostatic and membranous portions constitute the *posterior urethra* and the spongy portion the *anterior urethra*. The posterior and anterior portions are separated by the external or membranous, sphincter.

**The Prostatic Urethra** Beginning at its interior orifice the urethra lies at first in the prostate, which is fixed at the base by the vesical layer of the pelvic fascia, forming the superior layer of the triangular ligament. To this ligament the urethra is intimately connected, passing through it about one inch behind the symphysis pubis. Thus the prostatic urethra is that section of the canal between the vesical orifice and the deep layer of the triangular ligament. It is the widest and most dilatable part of the urethra. It passes from the base to the apex of the prostate, lying a little back of the median line, and averages about 3 cm in length. Its course is at first almost vertical, but lower down it makes a forward turn and emerges from the prostate just in front of the apex.

The verumontanum, or urethral crest, projects from the posterior wall, giving the lumen a crescentic shape in cross section, but if the *urethral canal is sectioned from in front*, the verumontanum will appear as a ridge extending the entire length of the prostatic urethra. The orifices of the ejaculatory ducts and utricle surround a slight tumefaction near the middle of this ridge. Below this point, the verumontanum becomes a distinctly visible crest, above, it broadens out to receive the ducts of the middle prostatic lobe. In the furrows to the right and left are the minute orifices of the numerous prostatic ducts.

*The Verumontanum and Sinus Pocularis* The verumontanum is a small, rounded, oval, elliptical, or conical elevation of the urethral mucosa, produced by the entering ejaculatory ducts and the sinus pocularis, or utricle. Its normally pale pink color is in sharp contrast to the darker surrounding mucosa making it readily observable through the urethroscope. It is separated from the prostate by a group of suburethral racemose glands arising from the floor of the prostatic urethra.

Though the dimensions of the verumontanum vary widely in different parts, most commonly the upper end rises abruptly from the urethral floor, its greatest height and width being at the point where the ejaculatory ducts and utricle open into the urethra, which is usually about 0.3 cm. below its upper end. Forward from this point the verumontanum gradually becomes smaller, its fibers being distributed among those of the urethral floor. At its lower end it spreads out until it is no longer distinguishable, being merged into bands of tissue, some of which may attach themselves to the lateral walls of the urethra.

On the anterior surface of the verumontanum (occasionally on the superior surface) is observable a round, crescentic, or slit-like opening about 0.5 cm. in length. This is the orifice of the *sinus pocularis* (*utricle, uterus masculinus*), an encapsulated glandular organ located in the middle of the verumontanum and paralleling the course of the urethral floor. Like its female counterpart the uterus, it is derived from the fused lower ends of Muller's ducts.

The structure and function of the sinus pocularis have been carefully studied by Rytina. Its acini, which vary considerably in number, size, and shape, open by smaller and larger ducts into a common duct which in turn opens on the anterior surface of the verumontanum. An interglandular stroma, arising in and forming part of the sinus wall, serves to separate the glandular acini. These glands often vary considerably, being at times simple and racemose and again exhibiting a distinct intracinous proliferation. The wall or base of the acini is composed of a flattened layer of connective tissue cells upon which are apposed the cells of the acini themselves. These may be simple columnar or simple cuboidal—more often the latter. Occasionally they are so closely packed as to appear squamous in type. Their nuclei are small, roundish, and usually stain well. The protoplasm is clear and also takes the eosin stain readily. Sometimes corpora amylacea are found in the glandular lumina, though usually they are empty. The common duct ordinarily pursues an oblique course through the sinus pocularis and is lined by the same type of epithelium as the acini. The entire sinus is enclosed in

a very firm capsule composed of fibrous tissue mixed with smooth muscle fibers, this is continuous with the sheath carrying the ejaculatory ducts, which open on the surface of the verumontanum to the right and left of the utricular orifice

McCarthy and his co workers found the sinus pocularis to average about 6 mm in length. Upon its floor and in its distal extremity prostatic tubules open, and within these, as well as in those opening into the sinus pocularis and in the lumen of the sinus itself, they found corpora amylacea. No definite layer of muscle tissue was made out as surrounding the utricle but wavy strands of elastic tissue were seen in close approximation to it.

**The Membranous Urethra** On its emergence from the prostate gland, the urethra passes downward and slightly forward between the superficial and deep layers of the triangular ligament. This portion of the canal is known as the *membranous urethra*. It extends from the apex of the prostate to the upper surface of the bulb of the corpus spongiosum and averages only 1.5 cm in length. Its lumen is much narrower than that of the prostatic portion. With the exception of the meatus it is the most firmly fixed and least dilatable part of the canal. This is because it is surrounded by the compressor urethrae muscle which lies between the two layers of the triangular ligament at this point. The walls of the membranous urethra are composed of non striated muscle fibers continuous with the muscle fibers of the prostate.

Close behind this section of the urethra lie Cowper's glands although their ducts open upon the floor of the fossa bulbi in the spongy urethra.

**The Spongy Urethra** After the urethra has passed through the superficial layer of the triangular ligament it enters the bulb of the corpus spongiosum, and throughout the remainder of its extent is invested by this structure, hence the term *spongy urethra* applied to this portion of the canal which extends from the triangular ligament to the external meatus. In its proximal (fixed) portion it inclines forward and slightly upward, but the distal penile portion, being freely movable follows the curve of the dependent penis.

The spongy urethra is composed of three parts the *fossa bulbi* the *penile* or pendulous portion, and the *fossa navicularis* in the glans. At a point about 2 cm from the posterior extremity of the bulb, where the urethral canal enters the corpus spongiosum the layer of erectile tissue is much thinner on the anterior than on the posterior surface but as it progresses the urethra lies more nearly in the center of the spongy tissue.

On entering the bulb the lumen of the urethra dilates somewhat, but as it nears the body of the corpus spongiosum it narrows again and maintains a uniform caliber until it reaches the glans penis, where it undergoes another dilatation, the *fossa navicularis*, thereafter diminishing to the slit like external meatus at the extremity of the glans

The roof of the spongy urethra contains the openings of numerous small indentations of the mucous membrane. These blind pockets are called *lacunae urethrales*. One, *lacuna magna*, is of quite large size and opens on the roof of the *fossa navicularis* about 2 cm. beyond the meatus.

Scattered over the surface of the spongy urethra, particularly on the walls and roof, are numerous small ducts of the submucous glands of *Littre*. These ducts are obliquely directed toward the meatus and open directly on the surface or into the lacunae. Each gland consists of a duct with a varying number of acini. They secrete a clear mucus. These tiny glands, as well as the lacunae, are of great importance in urethral infections since organisms gaining their depths are relatively inaccessible to surface treatment and frequently form foci of reinfection.

On the floor of the bulbous portion, just in front of the triangular ligament, are the orifices of the ducts of Cowper's glands.

**The External Meatus** The external meatus is a vertical slit, about 8 mm. in diameter, at the apex of the glans penis. It is the narrowest and least dilatable part of the entire canal, hence, an instrument which will pass the external meatus will pass through a normal urethra.

**Structure of the Urethra** The urethra is lined throughout by smooth glistening rather pliable mucosa plentifully supplied with glands. The submucosa is unusually rich in blood vessels. In the prostatic and membranous portions, involuntary muscle is found, but this disappears after the spongy portion begins so that no part of it is visible after the bulbous urethra has been passed. Above the submucosa are two layers of muscle fibers: an inner longitudinal layer and an outer circular layer showing especial development at the internal urethral orifice. The trigonal muscle runs down into the urethra, thus participating in the physiological processes concerned in the emptying of the bladder.

In the upper part of the prostatic urethra at the bladder neck the epithelium of the mucosa resembles that of the bladder, being transitional in character. In the *fossa navicularis* it is stratified squamous, like that of the glans penis. Elsewhere the epithelial lining is of a stratified columnar type.

The structure of the urethral mucosa is of great importance to the urologist because the numerous glands are convenient breeding places for infectious organisms—the gonococcus in particular. This glandular structure seems to be peculiar to man. Studies in comparative histology indicate that few of the higher mammals such as the elephant, camel, lion, and monkey, possess anything corresponding to the glands of Littre (for example) in the human (Hirsch). In lower types, such as the rat or guinea pig urethral glands are fairly well developed, and this is generally the case in mammals that do not possess prostates. This has led to the belief that urethral glands serve a fertilizing function in these lower orders of mammalia. The urethral mucosa of most mammals has been found to consist of squamous epithelium, though less often transition and stratified columnar epithelium has been found as well. Only monkeys show simple columnar cell structure. These researches in the comparative histology of the urethra offer an explanation of why so few mammals can be used in the investigation of the activities of the gonococcus. Squamous epithelium in the human is known to be particularly resistant to the invasion of the gonococcus, and the urethras of most of the higher types of mammals are protected by the squamous structure of their mucosal linings.

**The Urethral Muscles** Two sets of muscles are concerned in the functions of the urethra. (1) the expulsors—the *bulbocavernosus muscle* or the *accelerator urinae* (p. 227) and the longitudinal and circular fibers surrounding the urethra outside the mucous membrane, (2) the sphincters—the external sphincter (sphincter urethrae) and the complex muscular arrangement at the vesical orifice called the internal “sphincter.” These are better described in connection with the musculature of the bladder (pp. 950 and 968).

**Length and Caliber of the Male Urethra** Surgically at least the length of the urethra is a matter of considerable interest and one upon which there is rather a wide divergence of opinion. The average length in the adult is usually given as 20 cm (8 inches), of this 5 cm is the posterior urethra and 15 cm the anterior urethra. The prostatic portion averages 3 cm in length, the membranous portion, 1.5 to 2 cm, and the spongy portion, 1.5 to 1.55 cm.

It would appear from our investigations that, as the male grows older, there is a gradual increase in the distance from the vesical orifice to the upper margin of the verumontanum. Up to the fifth year this measurement averages 0.55 cm. During the second decade, the length of this

portion of the posterior urethra increases to 1.2 cm, and from then on there is a slow, gradual increase in its length until, in old age, the average measurement from the upper surface of the verumontanum to the internal urethral meatus is 1.85 cm.

**Lymphatics of the Male Urethra** The lymphatics of the spongy urethra join with those of the glans to follow the dorsal vein to the symphysis, where they form a plexus containing some intercalated nodes. From this plexus vessels pass in various directions to terminate in the deep inguinal and external iliac nodes. The lymphatics of the penile urethra also communicate, along the dorsal vein of the penis, with the prostatic plexus and the external iliac nodes.

Because of the difficulty experienced by anatomical investigators in injecting the lymph vessels of the posterior urethra (prostatic and membranous portions), comparatively little was known concerning their exact distribution until recently. The investigations of Parker (1935-36) have added considerably to our knowledge of the lymphatic system of the posterior urethra in the male and the entire urethra in the female, both of which have a similar arrangement. In an examination of specimens from 30 male infants it was found that the lymph channels of the posterior urethra course backward along the main pelvic arteries, most frequently to nodes located along the pubic branches of the obturator arteries, to nodes of the internal middle, and external chains of the external iliac groups to hypogastric nodes, and, occasionally, to lateral sacral nodes, to ischiatic nodes of the gluteal region, and to superior hemorrhoidal nodes. Variations in the branching and distribution of the pelvic arterial system determine to a large extent the courses taken by the lymphatics from the posterior urethra and the positions of their regional nodes.

### C ANOMALIES OF THE MALE URETHRA

A number of congenital malformations involving the male urethra have already been discussed in the section devoted to the male external genitalia: hypospadias (p. 234), epispadias (p. 237), and hermaphroditism and pseudohermaphroditism (p. 381).

#### *Congenital Absence of the Urethra*

Congenital absence of the urethra is an exceedingly rare anomaly, and is usually associated with absent or rudimentary penis (p. 230). A few instances of absence of the urethra with a normally developed penis

have, however, been reported. The associated conditions are apt to be incompatible with life, but should there be an outlet for the urine through the urachus or rectum, or should early surgical correction be possible the child may reach manhood.

Kaufmann (1886) collected from the literature 7 cases of what he regarded as true absence of the urethra, and 3 cases reported by Depaul wherein the urethra had formed during fetal life but had developed abnormally, so that it was reduced to a solid cord. These references we have been unable to verify. Lepoutre (1909) reported a case of complete absence of both penis and urethra in a child who died at birth. There was no anus and the rectum opened into the bladder neither urine nor feces having any outlet. The urachus was represented by a hard fibrous cord with no suggestion of a lumen. Nowhere was there the slightest evidence of even a rudimentary urethra. This author cites the case of Aievoli (1907) as an instance of partial absence of the urethra. The patient was 5 years old when examined. The penis was entirely absent urine being expelled from an opening at the base of the scrotum therefore the prostatic urethra was presumed to be intact.

### *Congenital Imperforation of the Urethra*

**Imperforation of the Urinary Meatus** Imperforation of the urinary meatus is the most common form of urethral atresia—the canal itself being normal. Opening of the outlet in the glans is a simple matter which can be done immediately the anomaly is discovered.

**Imperforation of the Urethral Canal** Congenital imperforation of the urethra itself, of greater or less extent, has been reported. Unless the urine finds outlet by the urachus or rectum such occlusions are incompatible with life.

In a case of partial congenital obliteration of the urethra reported by Lepoutre in 1929 the fetus was so greatly distended that the obstetrician was obliged to puncture the abdomen after cessation of the fetal heart beat, in order to effect delivery. Autopsy showed the enormous dilatation of the trunk to be due to complete obliteration of the spongy urethra although the corpus spongiosum and corpora cavernosa were entirely normal. Most remarkable was the fact that the extreme dilatation was confined to the bladder and ureters, the kidneys being practically normal and showing no dilatation of their natural cavities.

Ménegaux and Boidot (1934) reported a case of congenital obliteration of the entire penile portion of the urethra the urinary meatus being represented by a star shaped scar. This infant was relieved by the



formation of "an hypospadiac meatus" at the base of the scrotum, which the surgeons deemed sufficient until such time as he should be old enough to decide whether or not to undergo plastic correction of his anomalous condition. These French authors give an extensive literary review of imperforation of the meatus and obliteration of all or portions of the urethra, drawing freely upon the 1925 Paris thesis of Nicolaesco, and the reader is referred to these two papers for a more complete discussion of this interesting topic.

### *Congenital Stenosis of the Urethra*

**Congenital Stenosis of the Urethral Canal** Congenital constriction or narrowing of the urethra is not uncommon, and can occur anywhere along its course. Stenoses are, however, most likely to be located at the bulbomembranous junction or in the posterior termination of the fossa navicularis. *Congenital valves* fairly frequent causes of obstruction in the posterior urethra are discussed separately.

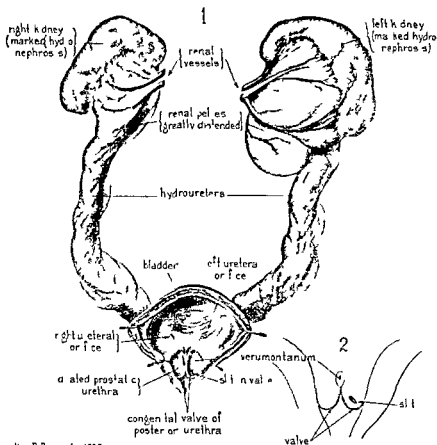
**Congenital Stenosis of the Urinary Meatus** Congenital narrowing of the meatus (pin hole meatus) is a quite common anomaly, especially in the male. It may be discovered at birth but more often weeks or even months pass before the anomaly is recognized. Straining and screaming during urination, or in marked cases distention of the bladder due to retained urine are the symptoms that usually direct attention to the meatus. Overflow incontinence is soon established but during the diaper period this may not be observed. In older children there is often a history of dribbling, and examination may disclose an excoriation of the meatal lips which is prevented from healing by the constant passing over it of small quantities of urine. Such an ulcer may produce hematuria, and the retention and penile irritation if not promptly relieved, may cause the early setting up of masturbatory habits.

A history of bed wetting may indicate a number of different urinary tract affections, but in considering them the examiner should first make certain that the meatus is adequate. The lips of a normal meatus may partially adhere, so that it will appear much smaller than is actually the case. To make certain, compress the meatus between the finger and thumb in an antero posterior direction—that is, in the direction of the line of the orifice. This will always show the true size of the meatus. If micturition can be observed, the size and direction of the stream will provide confirmatory evidence.

**Treatment** Early meatotomy is the treatment for all cases of meatal stenosis.

*Congenital Valves of the Posterior Urethra*

Congenital valves of the posterior urethra until fairly recently regarded as an excessively rare condition are now known to be the cause of many of the urinary disturbances of infants and boys, the etiology of



Wm P Dusch 1932

FIG 120 Case of congenital valve of the posterior urethra found at autopsy by Lowsley while on the staff of Bellevue Hospital (New York). The bladder has been opened and separated showing the diaphragm like valve entirely closing the posterior urethra except for a small slit to the left of the midline. This has caused an extreme grade of hydroureter and hydronephrosis.

which had long been sought in vain. They are, therefore, of considerable clinical importance. By inducing back pressure these obstructions produce serious progressive changes in the upper urinary tract which if untreated, frequently result in early death. While the majority of these

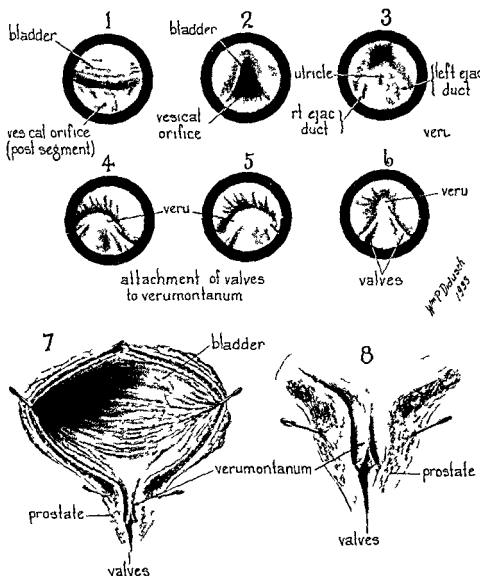


FIG 121 Congenital valves of the posterior urethra similar in type to that shown in the preceding illustration but not completely closing the urethra (1 to 6) Urethroscopic views of the vesical orifice and prostatic urethra using the Lowsley urethroscope 4 5 and 6 showing the strands of tissue extending laterally below the verumontanum (7 8) Reconstructions showing the bladder and prostatic urethra with the valves below the verumontanum

anomalies are now recognized early in life, a good proportion still escapes detection. As many of them are not completely obstructive, they may go unobserved until the occurrence of some urinary tract disturbance, usually an infection, induces complications which do not take place in an entirely normal urethra.

**Incidence** Valve like folds in the posterior urethras of infants and young children were first recognized by Langenbeck in 1802. The first complete study of the anomaly was made by N. Tolmatschew in 1870. All of the cases cited by him were discovered at autopsy. In 1913, Young recorded the cystoscopic diagnosis and first operative cure of congenital valves of the posterior urethra. Since then numerous cases have been reported, most of which have been diagnosed cystoscopically. A careful search of the literature by us in 1934 revealed a total of 130 reported cases to which we added 4 of our own. So many have since been cited that the anomaly can no longer be termed rare.

**Types of Valve-Formation** Three types of valve formation have been differentiated (Young *et al*, 1919).

*Type 1* shows a ridge on the floor of the posterior urethra commencing at and continuing as a part of the verumontanum. This ridge takes an anterior course and in the region of the bulbomembranous junction divides, fork like, into two processes which are attached in the form of a thin membrane to the circumference of the urethra at times completely encircling it.

*Type 2* shows a ridge more or less like that of the first type save that it passes from the upper surface of the verumontanum toward the internal sphincter, where it divides into two processes which continue as membranous sheets attached to the urethra just outside the internal sphincter.

*Type 3* shows membranes unrelated to the verumontanum. These may be found in any portion of the posterior urethra. The membranous structure is attached to the entire circumference of the urethra. In its center is a small orifice, sometimes no larger than a pin hole and again of such dimensions as to give the structure the appearance of two lateral folds. (Jarjavay called this an "iris valve" because of its resemblance to the iris of the eye.)

The concave aspect of the valves is always *toward* the bladder. This is of especial importance to the examiner, as it permits the free passage of instruments *to* the bladder, but down flowing urine causes the folds of tissue to balloon out so that micturition is greatly impeded or even inhibited.

**Etiology** None of the various etiological theories that have been advanced explains all types of urethral valves. Bazy, in 1903, pointed out that the urogenital membrane occupies the most common site of these anomalous valves until late in fetal development, therefore, he argues, the anomaly is most likely a fetal rest—that is, postnatal persistence of the membrane.

Lowsley, in a paper published in 1914, suggested that the obstruction is an anomaly of wolffian and mullerian ducts. In his studies upon the embryology of the prostate he had observed that these structures, which in the male become the ejaculatory ducts and prostatic utricle, enter the prostate near its base and pass through that gland in an oblique direction until they arrive at the urethra, where they turn and for a short distance run parallel to the urethra, into the lumen of which they finally enter. A sheath of firm connective tissue binds them together as they pass through the prostate. On their approach to the urethra they push up the urethral floor to form a mound—the verumontanum, but they still remain separate from the adjacent structures, their tissues being superimposed upon those of the urethra. Ordinarily, just below the orifices of the ejaculatory ducts and utricle, the tissues surrounding them merge with the fibers of the urethral floor, finally disappearing altogether. In a specimen seen by Lowsley these bands did not disappear. Instead, at a point where the verumontanum normally loses its identity, the fibers attached themselves to the entire circumference of the urethra save at one point, so that the lumen was almost completely blocked.

Another etiological theory was later advanced by Ernest M. Watson, who reported on a specimen of fetal urethra which, in cross section, showed three fibrous bands extending from the proximal portion of the verumontanum to the roof of the posterior urethra. This led Watson to believe that valve formation might arise from fusion of the epithelium in the roof of the posterior urethra with the colliculus in a very early stage of its development, at the time of marked epithelial activity of this and associated parts. This theory cannot explain all cases of valvular obstruction of the posterior urethra, particularly those arising from division of the ridge springing from the superior aspect of the verumontanum and the form of obstruction which is found in any part of the urethra and is unrelated to the verumontanum.

**Pathology** In male infants and boys with this obstruction, we find conditions very like those observed in middle-aged and elderly men suffering from prostatic hypertrophy: dilatation of the bladder, trabecu-

lation of its walls an hypertrophied trigone, and diverticula formation. The urethra directly behind the point of obstruction is first dilated, and after the bladder has for some time felt the effects of deficient drainage, the ureters become enlarged and their orifices gaping and patent. Hydro-nephrosis usually bilateral, inevitably follows and secondary infection



FIG. 122 Congenital valves of the posterior urethra and neurogenic bladder with bilateral hydronephrosis and hydro-ureter. Male aged 4 years

completes the typical cycle of urinary retention. In advanced cases with pronounced vesicorenal reflux the bladder is often contracted.

**Symptoms** The symptoms manifest themselves in two distinct ways (1) by the immediate effects of urinary obstruction (2) by the more remote effects of back pressure and urinary retention. One of these aspects may be more prominent than the other or both may be equally suggestive.

Often the symptoms are solely those of secondary infection, the general condition simulating that seen in prostatic hypertrophy. As practically all of these cases are seen in children, the mere fact that one observes in so young a patient manifestations usually associated only with middle or advanced age should suggest the possibility of congenital valves in the posterior urethra.

Chief among the symptoms is the small stream with diminished force, often a mere dribble, the urine coming out by drops with much straining and difficulty. The bladder, distended with retained urine, is often palpable as high as the symphysis. *Another characteristic finding is overflow incontinence with a lifelong history of urinary difficulty. Bed wetting frequently leads to a diagnosis of enuresis.*

In the advanced cases—the classification in which the few adult subjects belong—we see more definite effects of the chronic obstruction to the urinary outflow. When a child has survived for some time without attention having been paid to his urinary difficulties the clinical picture may resemble that of chronic diffuse nephritis or, to those familiar with it, the syndrome accompanying bilateral polycystic kidneys. In general the symptoms are those characteristic of long standing urinary retention and infection: loss of weight and appetite, nausea, vomiting, chills and fever, with profuse perspiration, and, unless relief be speedily afforded, terminal uremia and death in coma.

**Diagnosis.** Although the clinical picture is usually clear cut, and the obstructive lesions readily observable through the cystoscope or urethroscope, the difficulty lies in the chance that proper examination will not be made. The routine measures of urological diagnosis are certain to disclose the presence of anomalous valves; the danger is that they will not be put into service—and cystoscopic or surgical visualization of the valves is the only positive diagnosis of the cause of obstruction. Examination of the urine usually reveals pus, which may lead to a diagnosis of pyelitis if instrumentation is omitted. In advanced cases tests of renal function will show a greatly diminished output with indications pointing to chronic interstitial nephritis—namely, nitrogen retention, marked diminution in the carbon dioxide combining ability of the blood, and other characteristic findings.

In the examination of these patients the same care must be observed as in the examination of patients with prostatism. If, as is likely, retention has existed for some time the dilated bladder should be emptied by

gradual decompression before cystoscopy is attempted. This is usually best done with the indwelling catheter, though there are cases which call for suprapubic cystotomy quite as much as in prostatism. Even in advanced conditions, these preliminary measures may materially improve the systemic condition. As soon as blood examination indicates that such improvement has taken place, a more detailed exploration can be undertaken.

Intravenous urography is often useful in demonstrating bladder distention, twisted and enlarged ureters, and hydronephrosis, but it is upon the cystoscope or urethroscope that visualization of the valves—the only positive method of determining the cause of obstruction—depends.

The concavity of the obstruction is always *toward* the bladder. Instruments inserted into the urethral meatus pass readily to the internal sphincter, but the down flowing urine causes the valves to balloon out in such a way as to impede the stream even when there persists an aperture large enough to permit the passage of fluid. Even when suprapubic cystotomy has been done, it has sometimes been found impossible to pass an instrument through the sphincter *from* the bladder into the urethra, when the same instrument, inserted through the urinary meatus could be passed into the bladder without difficulty. The invention of cysto-urethroscopes especially designed for use in children has made possible the examination of even the youngest patient, though careful preliminary dilatation may be necessary before the instrument can be advanced.

After the bladder has been inspected, gradual withdrawal of the instrument will reveal the conditions in the urethra. There will be great dilatation of the urethra above the obstruction, so that observation will be easy and a good view of the pathological changes induced by the interference with drainage readily obtainable. Generally the valves and their attachments to the urethra can be seen during the withdrawal of the instrument. A preliminary cystogram will prepare the examiner for what he now sees. Advanced cases show a peculiar funnel shaped shadow after the bladder and posterior urethra have been permeated by the opaque fluid—the result of the extreme dilatation above the obstruction—which gradually widens as the bladder is approached.

**Treatment** The treatment is surgical removal (p. 685). After removal of the obstruction, treatment of secondary changes in the urinary tract is often required.



*Congenital Diverticulum of the Urethra*

Urethral diverticula are pouches opening into the urethral canal at any point along its course. They are usually so situated as to be always partially filled with urine, which decomposes and leads to urinary tract disorders of varying degrees. Lowsley and Gutierrez, in a very extensive review of the literature in 1929, collected 109 reported cases of urethral diverticulum in the male and added 6 of their own. Diverticula are *congenital* or *acquired* (p. 663).

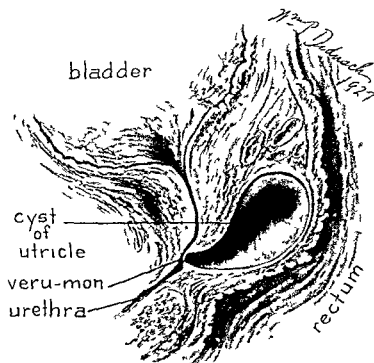


FIG. 123 Congenital cyst of the utricle (Redrawn from specimen in the collection of Dr. Legueu, Museum of Félix Guyon, Hôpital Necker, Paris.)

The congenital type is apparently rare. Johnson (1923) was able to collect only 38 cases from the literature. However, unless diverticula are seen in infancy or before secondary traumatic or pathological changes have occurred, it may be impossible to differentiate clinically the congenital from the acquired types.

**Etiology and Pathology** The exact etiology of congenital diverticula is not known. Voilemier believed that the congenital type, like hypospadias, is due to faulty closure of the urethral folds, the difference being that in diverticulum formation the urethra alone is involved, while in

hypospadias the defect extends through the skin. De Paoli explained their formation as due to hypoplasia of the corpus spongiosum urethrae with resultant bulging of the urethra into the pouch thus made on its ventral wall. Johnson believes that some diverticula and cysts may originate in persistence of embryonic epithelial rests. McKay and Colston (1929) mention a group of pseudo-diverticula—urine filled pouches communicating directly with the urethra and resulting from pathological dilatation of normal structures in the posterior urethra due to back pressure. Notable among such normal structures to suffer dilatation is the sinus pocularis. There is some doubt however as to whether the sinus pocularis capable of such dilatation can be entirely normal which would lead to the conclusion that some urethral diverticula are actually the secondary effects of preexisting congenital anomalies.

Diverticula are of two types whatever their origin. *True diverticula* are lined with mucous membrane identical with that of the urethra. *False diverticula* are formed in the periurethral tissue or urethral glands. Their walls are neoplastic in character and they would therefore be of postnatal origin in most cases. However a true diverticulum may lose its mucous coat through infection while a periurethral abscess may show after evacuation of the pus a true epithelial lining (LeComte). If such an abscess ruptures into the urethral canal it may drain so effectively as to eliminate the original infection entirely but the walls will not collapse sufficiently to obliterate the cavity and this persisting either with or without an epithelial lining may later be taken for a 'congenital diverticulum'.

Congenital true diverticula are almost always found on the ventral wall of the anterior urethra and may produce symptoms very early in life. The acquired type usually affects the posterior urethra.

**Diagnosis and Treatment.** In practice it makes little difference whether the pouch was present at birth or was acquired through dilatation due to obstruction, stone or other cause. Diagnosis and treatment follow along the same lines and are discussed under Acquired Diverticulum (p. 663).

### *Urethral Duplication Accessory Urethra*

**True Duplication.** *True duplication of the urethra with double penis* is excessively rare. Young having found only 5 cases up to 1926.

*Two complete urethras in a single penis* is almost equally rare. In a review of the literature on all types of urethral duplication up to 1916 MacKenzie found only 7 cases. In 1933, Heymann published a well

documented account of two separate urethras with individual meatuses. The roentgenograms showed opaque catheters inserted in the meatuses, with their tips in the bladder after having passed through separate vesical orifices. Another case of complete reduplication of the urethra within a single penis was described by Delvigne in 1934.

**Accessory Channels.** Accessory channels are much more common. As far back as 1891 Taruffi made a study of this anomaly and established

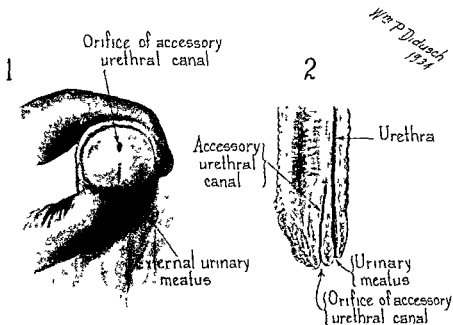


FIG 124 Blind-ending accessory urethral canal opening on the surface of the penis but having no communication with the normal urethra or bladder (1) Shows the orifice of the accessory canal above the external urinary meatus of the normal urethra (2) Sagittal section showing the relation of the accessory canal to the urethra. Infection in a narrow, blind-ending canal is very resistant to treatment, and in such cases complete excision of the accessory urethra may be necessary.

a classification that has been generally followed in later years. He distinguished four types of accessory channels.

(1) Semiferous canals—that is, separate canals for the conveyance of seminal fluid, entirely distinct from the normal urethra. These are rare, only 3 or 4 having been reported.

(2) Blind-ending canals. These are of two types: (a) accessory canals opening on the surface of the penis but having no communication with the normal urethra or bladder (Fig 124). These are common in hypospadias, the opening being usually on the under surface of the glans or

in the coronary sulcus. The accessory tract may, however, open on the dorsum, in some instances giving the appearance of an epispadias. (b) Accessory channels opening into the normal urethra, generally in front of the bulb, but ending blindly in the periurethral tissue. These are undoubtedly embryological defects and are not to be confused with the normal paraurethral ducts opening into the urethra and leading into short cul-de sacs.

(3) *Accessory canals communicating with the urethra at one or several points* in its course and opening on the surface of the penis. Bifurcations of the urethra may be from the bulbous, penile, or glandular portions and the opening is usually on the ventral surface, although it may be on the dorsum.

(4) Certain congenital urethral fistulas usually originating from defects in the embryonic cloaca.

Group 2 (a)—blind-ending canals opening on the surface of the penis but having no communication with the normal urethra—is the most common type of accessory urethra. Two such cases have come under our observation in recent years. In one, the accessory channel opened on the glans, about 1 cm above the normal urinary meatus, and extended to a point just under the symphysis near the base of the prostate. In the other, the accessory urethra opened at the top of the glans and extended backward and downward for a distance of approximately 4 cm. A careful review of the literature disclosed reports of 40 other cases in which the accessory tract had no communication with either the bladder or the urethra. In the majority of reported cases the possessor of the accessory canal remained in ignorance of his abnormality until he contracted gonorrhea, or until it was accidentally discovered during examination for other reasons. Infection in a narrow, blind-ending canal is particularly resistant to treatment and may continue as a subacute gonorrhea long after subsidence of the original attack. Surgical removal of these sources of chronicity may, therefore, be indicated.

*Treatment of Accessory Canals.* Frequently these anomalous tracts require no treatment whatever. When they do, the treatment of choice is complete excision (p. 696). Incision, and curettage of the epithelial lining, is not as satisfactory as excision. Conservative treatment with chemicals is of no benefit.

### *Accessory Meatus*

Although accessory urethras are fairly common, it is very rare to encounter, even in hypospadias, urethras with more than two openings

Boeckel (1918) reported a case of hypospadiac urethra with three meatuses. When the patient passed his urine a stream came from each orifice, and he informed his examiners that he likewise ejaculated from all three. He was 33 years old, and had had two attacks of gonorrhea, but apparently his excretory and sex functions had never been especially unsatisfactory.

In 1914, Girard, of Toulon, France, treated for gonorrhea a man with five openings on the under surface of his penis. The principal meatus was 3 cm. from the penoscrotal junction. Another orifice was near the normal site of the urinary meatus. Between them were three very fine openings. Examination proved that all five orifices opened into the urethra, the three intermediate ones having tiny accessory ducts leading to them from the main channel. When the patient urinated, most of the stream came from the opening near the penoscrotal junction, but a little dripped from the three intermediate openings. The gonorrheal discharge issued from all five orifices.

#### *Ectopic Ureteral Openings Into the Urethra*

An ectopic opening of the ureter into the posterior urethra may occur through some developmental defect in embryonic life (Anomalies of the Ureter, p 1220). In males, these openings are apt to occur inside the external sphincter, so that the urine is controlled. An unexplained incontinence in an otherwise healthy child may have its origin in an ectopic ureteral opening into the urethra, and this possibility should always be kept in mind when dealing with enuresis in either sex.

#### D PHYSIOLOGY OF THE MALE URETHRA

The urethra in the male has a dual function: (1) it serves for the passage of seminal fluid (Ejaculation, p 527), (2) it conveys the urine from the bladder (Physiology of Micturition, p 974).

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## CHAPTER XX

### INJURIES AND DISEASES OF THE MALE URETHRA

#### A INJURIES OF THE MALE URETHRA

Injuries of the male urethra are relatively common, and are of great importance because of their tendency to cause urinary obstruction, extravasation and infection, and stricture or fistula formation

##### *External Penetrating Wounds*

External wounds of the urethra, inflicted by bullets, splinters, knife blades, or other sharp pointed implements, are uncommon in civil life and are usually associated with injury to the penis (p 245) Bullet wounds are common in war and are likely to be complicated by severe trauma to the surrounding structures The treatment of such injuries is discussed under Rupture of the Urethra (p 679)

##### *Intraurethral Injuries*

Intraurethral injury may be produced by inept instrumentation, stones or other foreign bodies, or by burns from caustics

**Instrumental Trauma** Unskilled or too vigorous instrumentation may do grave injury to the urethra The beak of a resistant instrument (sound, cystoscope, catheter) may penetrate the urethral wall, making a false passage and producing profuse hemorrhage This is most likely to occur in the narrowed bulbomembranous region or in a pathologically deformed or obstructed posterior urethra The beak of the instrument will usually be found to have entered the wall at the apex of the prostate or between its lateral aspect and the rectum Cases of puncture of the urethral wall by the point of a urethral syringe have been reported Undoubtedly, the unwise use of instruments in inflamed or otherwise hypersensitive urethras is responsible for many strictures, periurethral abscesses, and even fistulas

**Foreign Bodies** A large or jagged calculus, evacuated from the bladder, may traumatize the urethral wall, though this is rare

The literature contains accounts of an astonishing variety of objects which have been introduced into the urethra by erotics or by intoxicated



or insane persons Pins, hairpins, glass stirring rods, slate pencils, pipe stems, knife blades, chewing gum, bits of steel, and wax candles are some of the things which have been mentioned A pointed object may perforate the urethral mucosa, resulting in the formation of a urinary fistula

The symptoms are dependent upon the degree of obstruction of the urethral canal and of mechanical irritation of the urethral wall Perforation of the tissues may be followed by such grave complications as urinary extravasation, infection, suppuration, and fistula formation The diagnosis is readily made by palpation, cautious instrumentation (to avoid forcing the object farther into the urethra), and roentgenography Histories given by patients may be entirely unreliable

Removal of bodies through the endoscope may often be accomplished Sometimes small, smooth objects may be pushed into the bladder whence they are removed with the rongeur Perineal urethrotomy is, however, necessary for the removal of many foreign bodies from the urethra, and incision of the pendulous urethra is occasionally required

**Burns** Burns of the urethra by chemical agents are probably more common than the small number of reported cases would indicate The literature on urethral burns was reviewed in 1935 by C Lepoutre, who observed that it was a subject rarely mentioned in urological text books Of the 14 cases listed by him, the injudicious application of silver nitrate, copper sulphate, chloride of zinc, and metallic mercury accounted for the largest number, but sulphuric acid phenol, corrosive sublimate, ammonia, alcohol, and ether are also mentioned One burn was caused by the improper use of diathermy In most cases the original injury was aggravated by the passage of instruments, and practically every one resulted in a stricture It is probable that slight burns which do not cause constricting scars seldom are reported in print

In any type of urethral burn, systematic dilatation over a long period is of the utmost importance In most cases, the physician who treats the original injury loses sight of his patient and is not permitted to give him the care which such injuries demand Phelps (1921) reported a case wherein a 10 per cent solution of silver nitrate was erroneously injected into the posterior urethra, resulting in extensive and painful burns Because the error was the doctor's, the patient willingly remained under treatment Two months after the mucosal injuries were fully healed, urethroscopy revealed the beginnings of stricture, the formation of which was prevented by careful systematic dilatation This case illustrates the benefits to be derived from continuous attention to these cases

Strictures due to burns from caustics differ from those resulting from urethritis—gonorrheal or non specific. They are located lengthwise of the canal their position being, of course determined by the manner in which the caustic substance was applied. Such a stricture is usually very tight and extremely resistant to dilatation, because it is formed not only of cicatricial tissue but also by a deep sclerosis of the corpus spongiosum. Thus, difficulty in passing urine arises not only from narrowing of the lumen at a given point but because the entire extent of the canal is rendered non-distensible. Erection may be very painful and the penis may be drawn downward until coitus becomes difficult or impossible. These characteristics readily distinguish urethral stricture due to burns from strictures caused by other trauma or gonorrheal urethritis.

*Treatment of Urethral Burns* The immediate treatment consists in alleviating the pain which is usually excruciating, neutralizing the caustic substance to prevent further injury, and providing for evacuation of the bladder. Irrigating the urethra with warm physiological salt solution (always at hand when suitable antidotes may not be) is often effective, although care must be taken not to diffuse a liquid caustic further up the canal. Soothing suppositories or even an injection of morphine, should be employed if the pain is great. If it is possible to pass a soft rubber catheter, urination can easily be taken care of. More often than not however, this is out of the question, and suprapubic cystostomy or perineal drainage will be necessary.

After the urethral mucosa has healed the urethra should be dilated at regular intervals over a considerable period of time in order to prevent stricture, which otherwise is an almost certain aftermath.

### *Rupture of the Urethra*

*Incidence* Rupture of the urethra is the most common as well as the most serious, traumatic accident to which this portion of the urinary tract is subject. Although O Connor, reporting on 8 cases of urethral rupture due to falling astride a loose man hole cover, says that rupture of the urethra is steadily becoming rarer and is now mostly confined to too adventurous children, hospital records do not bear him out and the ever mounting toll of highway accidents continues to raise the incidence of this lesion. Simpson Smith, reviewing the literature from 1913 to 1935, was able to collect 381 recorded cases to which he added 8 of his own. An accident known to have occurred almost 400 times in 22 years can hardly be termed rare.

**Etiology.** The most common causes of rupture of the urethra are falling astride a hard, narrow object, blows or kicks in the perineum, and fracture of the pelvis with attendant injury to the urethra from bone fragments or crushing against the bony structure. A few cases have been reported of rupture incurred during coitus, violent muscular effort, and catching the penis in moving machinery.

**Pathology.** The most common sites of rupture are (1) in the bulbous urethra, anterior to the superficial layer of the triangular ligament; (2) in the membranous urethra. Rupture of the penile urethra sometimes occurs in conjunction with penile injuries. Rupture in the prostatic urethra rarely occurs except in association with fracture of the pelvis, of which it is, however, a fairly frequent complication. Rupture in the bulbous urethra, the most common type of injury, is usually due to straddle injuries or blows in the perineum.

Extravasated urine and blood is directed and controlled by the layers of the urogenital trigonal muscle and Colles' fascia. The superficial perineal pouch (Colles' pouch) is formed by the attachment of this fascia to the lower parts of the ischiopubic rami, but anteriorly Colles' fascia spreads over the scrotum and penis to unite at length with the fascial structures of the abdominal parietes (Scarpa's fascia). When the bulbomembranous urethra is injured, the urine extends beneath Colles' fascia, filling the superficial perineal pouch. The extravasated urine is prevented from extending to the thighs by the density of the fascial layers below Poupart's ligament. From the superficial perineal pouch it extends anteriorly beneath the dartos of the scrotum and penis and up over the abdomen beneath Scarpa's fascia. Rupture of the bulbous and membranous urethra, therefore, will usually be manifested by swelling and ecchymosis of the perineum and scrotum—evidences not visible when the injury is in the pendulous portion, in which case extravasation is usually limited to the penis by Buck's fascia.

Of particular importance is the relation of the site of rupture to the triangular ligament—that is, whether it is anterior to, within, or posterior to that ligament. When rupture is within the ligament, the superior layer may also be ruptured, in which event extravasation will be upward into the space of Retzius.

The rupture may involve only the interstitial portion of the urethral wall, the mucosa being intact. In these cases urinary extravasation does not occur. More often, however, there is dissolution of its continuity, with extravasation of urine into the neighboring tissues. Rup-

tures involving the entire thickness of the urethral wall may range from a tiny tear (transverse or longitudinal) to complete severance. The edges of the rent may be so injured and devitalized as to prevent spontaneous healing. In complete rupture the natural elasticity of the urethra will cause retraction of the torn ends to the extent of an inch or more. This type of rupture occurs most often in the bulbous urethra. The bulb may be wrenched from the membranous urethra, an injury very difficult to treat satisfactorily.

**Symptoms and Diagnosis** Prompt and accurate diagnosis is imperative. Early and proper treatment is not only necessary to save the patient's life in the majority of cases, but will prevent the formation of stricture and its complications.

The diagnosis can usually be made without much difficulty, although the extent of the injury cannot be established clinically. The history is generally significant. A history of falling astride, or of a blow or kick in the perineum, with pain in the urethral region and hemorrhage from the meatus, is strongly suggestive, although sufficient time may not have elapsed for the evidences of extravasation of blood and urine into the tissues to be manifested. Indeed, it is never safe, with the history of a fall upon the perineum, to neglect the possibility of a rupture of the urethra. Where there is fracture of the pelvis also, the probability of rupture of the urethra should never be overlooked. Such injuries vary greatly in extent. There may be merely an abrasion by a bone fragment when there has been severe pelvic injury, on the other hand, complete severance of the urethra has been seen when the adjacent tissues were entirely unharmed.

The chief signs and symptoms pointing to urethral rupture are pain in the perineum, sometimes radiating to the meatus, bleeding from the meatus, perineal hematoma and urinary retention. In rupture of the posterior urethra there is frequently profound shock. Except in rare instances, there will be absolute inability to void the urine and extravasation will soon begin. Occasionally, however, a patient will pass a little blood tinged urine, or he may be able to urinate at the first attempt but not thereafter.

Extravasation into the surrounding tissues of urine mixed with blood is one of the gravest features of urethral rupture. If the perineum has escaped extensive laceration, the extravasation may be confined to the immediate site of injury, but as perineal injury is the rule, the extravasation is likely to extend into the injured perineal tissues and thence to

the external genitalia and the abdominal wall, but not, ordinarily, into the tissues of the *groin*. Secondary infection may produce serious and even fatal complications. Prompt relief is therefore imperative.

The diagnosis of rupture of the urethra is usually made by rectal palpation after careful scrutiny of the perineum and lower part of the abdomen. For exploration of the urethra only soft rubber catheters are safe. Ordinarily, a catheter cannot be passed, but if the injuries are not extensive, and severe inflammatory reaction has not yet set in, the instrument may pass. The dangers of forcing even a soft rubber catheter into a ruptured urethra are, however, considerable, as the passage of the instrument is likely to increase the damage already sustained and induce further hemorrhage. Rupture of the posterior urethra, when accompanied by a pelvic fracture and profound shock, may be difficult to differentiate from a rupture of the bladder.

**Treatment** If extravasation has not occurred, and if the injury to the urethra is not too extensive, a catheter may sometimes be passed and the urethra "splinted" upon the instrument. In more serious injuries prompt diversion of the urinary stream and drainage of the extravasated regions are of first importance (pp 679, 684). The best judgment is needed to decide when to operate upon the injured urethra and to select the operative procedure best suited to the condition present. Surgeons differ as to the advisability of immediate operative repair. In extensive injuries, particularly those associated with pelvic fracture, operative repair must frequently be delayed until the patient has recovered from the shock and immediate danger.

The surgical treatment of ruptured urethra is discussed on page 679.

## B DISEASES OF THE MALE URETHRA

### *Gonorrhea*

This subject is covered in a separate chapter (*Gonorrhea in the Male*, Chapter XXII).

### *Syphilis of the Urethra*

Syphilis of the urethra, though uncommon, is observed often enough to merit greater emphasis than most authors accord it.

**Pathology** The urethral lesions may be primary, secondary, or tertiary.

The initial *chancre* is most commonly observed on one of the meatal lips. When located within the urethra it is likely to be found in the

*fossa navicularis* A chancre on the meatus is apt to be classed as penile, and one situated higher up in the canal may easily escape detection—which may account in part for the apparent rarity of the lesion

The pathological changes of chancre have been described elsewhere (p 267) As a matter of clinical experience an intraurethral chancre is not likely to be discovered until it has advanced to the stage of hardening and ulceration when it may be detected by the palpating finger as a hard mass in the pendulous urethra The surrounding tissues are usually edematous Endoscopy will generally reveal the lesion as an ulcer with rolled and indurated edges the induration sometimes being sufficient to cause partial occlusion of the urethral lumen If the necrotic stage has already been reached by the time medical attention is sought there may be abscess formation or a fistula which is likely to prove very intractable Healing may be followed by stricture due to shrinkage of the fibrotic tissue Such strictures in contradistinction to those resulting from gonorrhea are usually in the anterior urethra

*Macular lesions* are not often seen in the urethra and little is known about them

In the tertiary stage of syphilis *gunmas* of the urethra may form particularly in the anterior portion Primary gumma of the urethra is very rare most of these lesions being secondary to gumma of the penis At the outset a urethral gumma may cause more or less obstruction of urination but these lesions tend to soften and break down very early so that the stricture is of short duration This disintegration may produce temporary hematuria which being painless may not sufficiently alarm the patient to cause him to seek medical advice

*Cylindrical syphilomas* have been described This is a rare syphilitic manifestation which occurs as a regular cylindrical infiltration of a segment of the urethra Upon palpation it gives the feeling of a sound in the canal because of its symmetrical roundness Small gummatous nodules may accompany this unusual formation This type of lesion is composed largely of sclerotic tissue and is very resistant to treatment more or less permanent contraction of the urethral lumen remaining

*Symptoms and Diagnosis* Intraurethral chancres are difficult to diagnose since they frequently give few or no characteristic symptoms Induration of the tissues just beyond the meatal lips is characteristic and is an important diagnostic finding The passage of urine over a chancre within the canal is apt to cause pain and as syphilitic lesions are ordinarily painless this fact may cause confusion in diagnosis The watery discharge commonly present may readily be mistaken for non

specific infection If induration is marked, there may be complaint of a 'lump' in the penis The inguinal nodes usually show more or less involvement, but this occurs also in other urethral and penile lesions and is suggestive rather than conclusive The breaking down of a gumma may cause temporary painless hematuria which is seldom profuse enough to send the patient to the doctor

Intraurethral chancre occurring coincidently with acute gonorrhea may readily be overlooked The chancre's presence is likely to be entirely concealed by the inflammation induced by the activities of the gonococcus Careful palpation, however, will usually detect the characteristic 'hard feel' of chancre Examination of the secretion for spirochetes will readily reveal them if present, the danger is that in cases where a previous diagnosis of gonorrhea has been confirmed by laboratory tests no further examination may be made during the acute stage, and the syphilitic infection will remain undetected

There is a possibility of confusion between syphilis, tuberculosis, and malignancy In tuberculosis, the urethral lesions are usually secondary to other tuberculous foci, there is pain throughout the act of urination, the urethral lumen is narrowed, and the discharge contains tubercle bacilli In malignancy, there is also pain, the discharge is fetid and serosanguineous, inguinal adenitis is very marked, and the endoscopic appearance of the lesion is usually characteristic of malignancy

In urethral lesions syphilis, though uncommon, should always be ruled out by the usual tests, otherwise, syphilitic lesions in this location, because of the scarcity or absence of characteristic symptoms, are likely to be overlooked particularly when there is a coexistent gonorrhea

Treatment Treatment is antisyphilitic Abscesses, fistulas, and stricture may require local treatment

### *Tuberculosis of the Urethra*

Tuberculosis of the male urethra is undoubtedly a rare condition, even in patients with a generalized urogenital tuberculosis Pavel, in 1,455 autopsies on tubercular subjects, found urogenital tuberculosis 380 times but urethral lesions in only 7 of these cases That tuberculosis is ever primary in the urethra is doubted by some authors Urethral tuberculosis, however, assumes the character of a distinct disease in proportion to the extent of the implication of the anterior urethra When the posterior urethra only is involved, it is hardly to be distinguished from tuberculosis of the bladder or prostate

Etiology Urethral tuberculosis may be an extension from an infected

prostate bladder or bulbo-urethral gland That it may occur through coitus is possible though apparently uncommon Infection of the urethra by contact with infected urine or seminal fluid is also possible Gonorrhea especially if the infection has become chronic and lesions of long standing are present in the urethra may predispose to the engrafting of a tuberculous process upon the affected area

Urethral tuberculosis is associated more often with tuberculosis of the genital tract than with that of the urinary tract Even when the kidneys and bladder are extensively diseased the urethra generally remains unaffected

**Pathology** Tuberculosis of the urethra begins as a chronic urethritis more commonly in the posterior urethra but whether originating in the posterior or anterior urethra it may spread throughout the entire canal The cavernous structures may become involved deeply and one or more urinary fistulas may form Rarely a stricture occurs with healing

Three types of lesions may be present—granulation tissue ulceration and caseous infiltration although the different types are seldom observed simultaneously Any type of lesion may cause stricture or lead eventually to fistula formation

Stricture is dependent upon a certain amount of healing of the original inflammatory invasion and is more likely to occur in cases where there is clinical improvement than where the condition is desperate when first coming under treatment Because urethral tuberculosis tends toward ulceration and active destruction of tissue rather than toward the formation of fibrotic tissue fistula is a more commonly observed advanced lesion than is stricture

*Pelouze's Bodies* Pelouze (1911) called attention to certain lesions in the urethra which he regarded as invariable local manifestations of an active tuberculosis elsewhere in the body He had observed in the posterior urethra small slightly pedunculated or sessile masses of tissue springing from a mucosa that seemed little if at all inflamed These bodies vary considerably in size Early in the systemic infection they are solid masses of tissue of a pearly white or rarely red color Later they undergo a cystic change in which stage they rupture easily and exude a whitish substance They are usually found upon the lateral urethral walls just distal to the vesical neck but may occur upon any portion of the prostatic urethral wall or verumontanum They are typical tuberculous tissue in which tubercle bacilli are demonstrable Pelouze believes that these bodies appear very early in the course of a



tuberculous infection and should always stimulate the examiner to make a minute search for evidence of tuberculosis elsewhere

**Symptoms and Diagnosis** In the early stage of the disease no symptoms occur With ulceration, there is pain during urination, frequency, hematuria, and usually a thin, slightly purulent discharge Urinary urgency is likely to be distressing and erections painful With the formation of scar tissue, there may be symptoms of stricture

Examination should include careful investigation of the genital tract—epididymes, vasa deferentia, seminal vesicles, and prostate—for evidences of tuberculosis The urethral discharge and the urinary sediment should be examined for tubercle bacilli Extensive involvement of the urethra may produce rigidity of the entire canal Induration and infiltration of the tissues, or, more commonly, the extreme sensitivity of the diseased urethra, may render instrumentation impossible, but if the urethroscope can be passed the ulcerative and caseated appearance characteristic of tuberculosis of the genital region will usually be plainly evident Stricture without a history of trauma or acute urethritis is suggestive of tuberculosis

**Treatment** In the treatment of urethral tuberculosis general hygienic measures (p 1196) and treatment of the primary focus of infection are most important Extirpation of a neighboring tuberculous process or of a tuberculous kidney, frequently results in spontaneous healing of the urethral lesions unless the disease has progressed to the relatively late stages of stricture and fistula formation Local treatment is of little avail, however, if other foci of tuberculous infection, outside the urogenital tract, can be demonstrated

Considerable relief may sometimes be obtained by light fulguration or soothing irrigations Dilatation may be necessary in case of stricture, but should be practiced with the utmost caution and avoided if possible Diversion of the urinary stream, by suprapubic cystostomy or perineal urethrotomy, will benefit some cases In advanced cases, with general involvement of the urogenital tract, more radical surgical intervention may be wise Cystectomy with ureteral implantation has been shown to have practical value The radical operation upon the seminal tract (p 510) may aid by removing adjacent foci of infection

#### *Trichomonas Vaginalis Infestation*

The conception of this organism as an invader of the urinary organs is something very recent Much still remains to be learned of its mor

phology, mode of transmission, and pathogenicity. Long considered an infestation peculiar to the female genitalia, it is now established that the *Trichomonas vaginalis* may be a cause of urethritis in the male, and must be taken into account whenever a male patient presents a urethritis for which no quickly recognizable cause can be assigned.

**Bacteriology.** The *Trichomonas vaginalis* is a protozoan possessing a piriform or spindle shaped body, the anterior pole of which is equipped with four long flagella. From the posterior pole an axostyle projects. Between the two poles an undulating membrane extends from the anterior end to about the middle of the body on one side. In size, it is smaller than an epithelial cell, although larger than a polymorphonuclear leukocyte. In common with other organisms of the same order, the *Trichomonas vaginalis* progresses in counter clockwise rotation, using a jerky forward movement, propulsion being by means of a whip like action of the flagella and the undulation of the membrane. It supposedly propagates by binary fission. The organisms are somewhat difficult to study because staining methods fail to show them. They can, however, be readily detected if a fresh drop of secretion is examined under the high power lens.

**Symptoms and Diagnosis.** Although most patients seek medical advice because of a distressing discharge with marked inflammatory symptoms, it is altogether likely that many men are infected during coitus, and, while harboring the organism, suffer such slight reaction that they are unaware of the infestation until another organism invades the urethra, setting up a mixed infection. Often the only complaint is of a slight watery discharge. Patients who have had gonorrhea are likely to attribute the symptoms to a recurrence of that malady. The discharge is at first mucoid then rapidly becomes purulent.

The diagnosis is established by finding the organisms in the urethral discharge.

**Treatment.** Prophylaxis, beginning with inspection of the female with whom the patient has recently had sexual relations is of first importance. If the infestation can be established in the woman she must, of course, be subjected to treatment also.

Methods of treatment which have proved effective are urethral irrigations, with mercuric oxycyanide, 1:4,000, or acriflavine, 1:3,000 prostatic diathermy, followed by the injection of acriflavine, 1:3,000 into the bladder, irrigation of the posterior urethra with metaphen, 1:8,000 and the injection of a colloidal silver preparation into the lateral lobes of the

prostate Most of the suggested treatments are based on the idea that the focus of infestation is usually in the prostate

### *Non Specific Urethritis*

**Etiology** Under the heading of non specific urethritis are classed as a rule all urethral inflammations which cannot be proved to be gonorrhea syphilis *Trichomonas vaginalis* infestation or tuberculosis Most of them are caused by organisms regularly resident in the urethra chiefly the colon bacillus streptococci and staphylococci Mixed infections are also frequent

Non specific urethritis is associated commonly with prostatoseminal vesiculitis cystitis or pyelonephritis A virtuous wife may present a non specific leukorrhea so irritating as to cause serious inflammation of her spouse's mucous membrane (The cure for this is appropriate treatment of the female partner) Masturbation is a frequent cause Traumatism of the urethra through the presence of foreign bodies by rough instrumentation or by caustic injections may produce urethritis Any obstruction in the urethra may cause a chronic discharge Strictures due either to previous trauma or to gonorrhea that has been eradicated so far as the infective organisms are concerned may cause urethritis So also may a meatus that is too small for the urethral caliber Tumors and polyps are rarer causes Urethritis from any cause may become chronic where there is a redundant foreskin or a pin hole meatus

**Diagnosis** The diagnosis can usually be established by examination of specimens obtained by massage but this measure should be carried out with caution The possibility of tumor and of an infection such as tuberculosis syphilis or *Trichomonas vaginalis* infestation must be kept in mind Traumatic urethritis and that due to chemicals are usually differentiated easily by the history The urine should be examined by both physical and laboratory methods Instrumentation should be employed with judgment and reserve as the too hasty introduction of catheters and sounds may increase rather than help the trouble If examination of the discharge and urine does not yield definite information and if the urethra will not tolerate an instrument resort to intravenous urography may be necessary

Other infectious organisms lodge in the urethral glands and ducts exactly as does the gonococcus and should be hunted for with the same thoroughness

**Treatment** The measures useful in mild gonorrheal infections are

generally applicable to non specific urethritis also. Irrigations benefit some cases but not all. To wash the discharge backward into a portion of the canal that may be still uninfected is merely to invite failure of subsequent curative efforts. If the urethritis is due to a focal infection elsewhere in the body or to a systemic condition attention must be given to this. Diabetes for example may make such a discharge peculiarly stubborn. The need for urinary antiseptics varies with the individual case but should always be considered when planning the therapy. Urethritis no matter what its origin is often much benefited by systematic diathermic treatment. The urethra seems especially responsive to heat and some practitioners utilize it in the treatment of practically all urethral lesions.

The sulfa drugs have been found very effective in eradicating the organisms responsible for most types of non specific urethritis. Mandelic acid is another useful drug particularly for bacillary infections.

#### *Urethral and Perurethral Abscess*

**Urethral Abscess.** Abscesses within the urethra proper are relatively infrequent. Such abscesses are usually gonococcal in origin but other organisms may also be responsible.

Folliculitis is frequently a troublesome complication of gonorrhea (Gonorrhea in the Male p 710). During an acute attack the gonococci may invade the small urethral glands making it possible to palpate these glands as small nodules upon the surface of the penis. There may also be present in the urethral floor anomalous glands which tend to form blind-ending pits into which gonococci or other pathogenic organisms make their way and remain embedded for years usually lying dormant but now and again setting up a subacute inflammation and preserving the unfortunate patient's infected state indefinitely.

A variety of causes may stir up inflammation in these glands among them the ingestion of alcohol frequent erections and nocturnal emissions and trauma from accident or unskilful or injudicious instrumentation. Endoscopic inspection will show the inflamed and angry state of their duct orifices and in cases where the glands are palpable but their ducts not yet completely occluded slight pressure commonly causes a drop of pus to exude upon the surface.

If the ducts continue patent so that drainage is free these small abscesses seldom cause serious trouble and subside quickly under suitable treatment but occlusion of the duct orifices by inflammatory swelling

prevents escape of the secretions and favors abscess formation. Such an abscess may rupture into the periurethral tissues, but more often the contents are forced through the orifices of the ducts into the lumen of the urethra and appear as a mucosanguineous discharge at the meatus.

These tiny urethral glands may become infected by organisms other than the gonococcus, but this is not common. Occasionally their orifices become sealed, when the secretion within them is sterile, thus forming a cyst. More often, however, the presence of pathogenic organisms results in abscess formation. A cyst wall appears through the urethroscope, as a thin white membrane, and an abscess plainly advertises itself by the yellow color of the contained pus. Occasionally a cyst or abscess is buried so deep in the mucosa that the urethroscope fails to reveal it, but external palpation will usually locate the affected gland, which will feel like a pea or a shot when pressed against the endoscopic tube within the urethra.

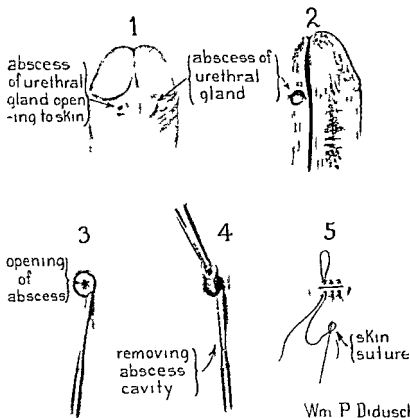
**Periurethral Abscess** Periurethral abscesses may form in any portion of the anterior urethra, but are more frequent in the fossa navicularis, where the glands are more numerous and the tissues more subject to trauma. Ordinarily, such abscesses occur singly and point to one side of the frenum, but multiple abscesses may arise on both sides, giving the entire area an edematous appearance. More severe and intractable than those of the fossa navicularis are abscesses which gather just anterior to the bulb. An abscess in the bulboperineal region may cause extensive infiltration of the perineum before burrowing through.

A periurethral abscess usually manifests itself as a hard, palpable swelling surrounded by an area of inflammation and infiltration. Some times the abscess ruptures upon the external surface, when it may leave a permanent urinary fistula.

**Treatment** The metamorphosis of a folliculitis to a urethral or periurethral abscess can usually be avoided by prompt recognition and treatment. At the first suggestion of inflammation of the follicles, all irritating influences, especially medication and instrumentation, should be discontinued. If the formation of pus cannot be aborted, the abscess should be incised to prevent spontaneous evacuation on the external surface, which is almost certain to result in a fistula, the surgical closure of which is likely to be difficult.

When abscesses have evacuated spontaneously into the urethra or have been opened by the surgeon, the after care of the site should receive

special attention. Most urethral abscesses are the result of suppuration in the tiny urethral glands. At present, the generally accepted treatment is the extirpation of the infected gland by diathermy. This is a simple procedure which usually brings about prompt relief of symptoms. It should be remembered, however, that the formation of scar tissue in the urethra tends toward contraction of the lumen, and unless dilatation

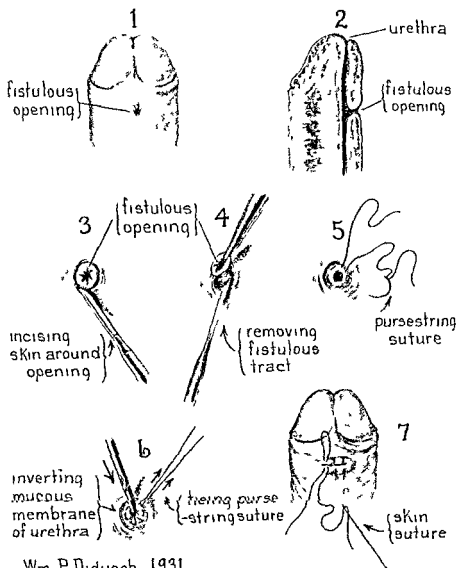


Wm P Didusch

FIG 123. Perirethral abscess. (1, 2) Shows abscess of urethral gland having no communication with the urethra. (3, 4, 5) Excision of perirethral abscess.

is undertaken from time to time, even comparatively slight lesions may be the remote cause of disabling strictures. Irrigation with mild antiseptics during the healing process will help to keep down secondary infection and lessen the formation of fibrous tissue, but it should never be regarded as a proper substitute for systematic dilatation carried out over a period of time.

Figure 125 shows a periurethral abscess and its surgical excision, figure 126 a urethral fistula, resulting from rupture of a periurethral abscess, and its surgical treatment



Wm P Didusch 1931

FIG 126 Urinary fistula resulting from rupture of periurethral abscess (1, 2) Shows the external opening and the connection of the fistulous tract with the urethra (3 4) Excising the fistulous tract (5, 6) Closure of the urethral opening by placing a purse-string suture around the opening and inverting the urethral mucous membrane (7) Skin closure

*Benign Tumors of the Male Urethra*

Benign growths of the male urethra are quite common. The majority are of inflammatory origin.

**Cysts of the Urethra** Cysts of the urethra due to inflammatory occlusion of the lacunae, Littre's glands, and anomalous glands sometimes present in the urethral floor have already been described (p. 645), as have the lymphocystic lesions of the posterior urethra believed to be associated with tuberculosis (Pelouze Bodies, p. 640). Cysts of the prostatic urethra and vesical orifice arise as a rule from inflammatory occlusion of the ducts of periurethral and subcervical glands. They are usually multiple and small, although larger and more thickly packed together than the cysts of cystitis cystica. They are undoubtedly retention cysts, and are often confused with polyps occurring in this location. Aside from the above, cysts of the male urethra are rare. One seen by us presented at the urinary meatus, and was easily removed *in toto* under local anesthesia.

**Polyps· Papillomas Adenomas** *Polyps* may involve any portion of the canal, but are usually found in the folds of the mucous membrane lining the fossa navicularis or the bulb. Clinically, it may be difficult or impossible to distinguish benign fibrous polyps from papillomas and Pelouze bodies, but as far as treatment goes this is of little importance.

*Papillomas* also may occur anywhere in the course of the urethra, but they are most commonly found in the posterior urethra and about the vesical neck. They appear in various forms, such as flat, sessile warts, or bulky, exuberant growths, or long, thin strands resembling seaweed—very soft and friable and in color almost every shade of red. A solitary papilloma is likely to arise in the bulb, while the multiple growths, occurring in groups or "nests" are commonly found near the meatus and at the vesical orifice. These growths are more prone to be sessile than pedunculated. They often have a cleft surface and numerous outgrowths. Through the urethroscope they appear as rough, wart-like excrescences, usually of a pale pink color and of a glistening appearance. They are easily rubbed off, leaving a freely bleeding base.

*Benign adenomas*—sessile or pedunculated—are sometimes found in the prostatic urethra, the epithelium beneath which they lie being usually normal when viewed through the urethroscope. These are glandular or tubular structures. Blood and lymph channels are found in them, and in general their structure is strikingly similar to that found in specimens from hypertrophied prostates. This has led some pathologists to suggest that urethral adenomas may actually arise from tubules



of the prostate in the adjacent urethral floor, but others maintain that a more likely origin is from the uncomplicated racemose glands so numerous in the urethral mucosa

**Fibromas and Myomas** These solid, encapsulated tumors, while occasionally found in the female urethra, are so extremely rare in the male as scarcely to enter into the diagnostic picture. Their symptoms are similar to those of polyps and papillomas

**Angiomas** Urethral angiomas also predominate in the female—the urethral caruncle, confined wholly to the female, being an example. Angiomas of the male urethra are of slight clinical importance. They consist merely of local thickening of the posterior wall near the meatus, with varicosities running through the affected area. Their etiology is unknown, but they are probably due to the same causes that operate to produce varicosities elsewhere, as in the legs and rectum. In males, long standing or other occupational strains may be responsible for the development of urethral angiomas

**Symptoms and Diagnosis of Benign Urethral Growths** Benign urethral growths, such as cysts, polyps and papillomas, may occur in such numbers as to cause partial obstruction, but frequently they cause little inconvenience unless irritated, when they may bleed very freely. These lesions are often associated with a prostatoseminal vesiculitis or posterior urethritis, and symptoms, when present, may be referable to the sexual as well as to the urinary sphere. Frequency of urination, urgency, and a urethral discharge are the most common complaints. Benign urethral tumors may not only be the direct cause of a chronic urethritis, but frequently they exaggerate and maintain a posterior urethritis or prostatitis originally due to other causes. This, and the possibility of such growths eventually becoming malignant, make their removal advisable

Careful urethroscopic inspection will reveal the presence and location of such growths though it will rarely permit differentiation between polyps, papillomas, and the rare solid tumors. The differential diagnosis, therefore, must rest on histological examination

**Treatment of Benign Tumors** All types of benign tumors of the urethra are readily removed through the urethroscope. The smaller growths may be directly fulgurated, while larger masses are usually dissected out with the thermocautery knife. The Lowsley urethroscope (p. 90) serves excellently for fulguration or cold excision, while the Kirwin resectoscope (p. 913) has proved efficient in the management of

the larger growths by thermocautery. No matter what method is used for removing these tumors, the greatest care must be taken to avoid complete penetration of the urethral mucosa, as the fistula that is almost certain to result is likely to prove very intractable.

Healing is promoted by cleansing irrigations and by rendering the urine bland through medication and the forcing of fluids.

It should always be remembered that benign urethral tumors are usually souvenirs of an associated infection in the urethra or allied glandular structures and unless this infection receives proper treatment and is permanently eradicated, the tumors will in all likelihood, recur.

### *Malignant Tumors of the Male Urethra*

#### CARCINOMA OF THE URETHRA

Carcinoma of the male urethra must be ranked among the rarer urological lesions. A review of the literature by Kirwin in 1932, in connection with the publication of a case of epithelioma of the male urethra revealed only 99 authenticated cases. McNally collected 6 more from the literature in 1935 and added one of his own. In 1937 Goldstein and Abeshouse found 111 cases and added one from their own experience. There is a general impression that urethral carcinoma is more prevalent in men than in women but our investigations do not bear this out.

Malignancy of the urethra must be differentiated from that of the glans penis prostate and Cowper's glands. Often however, the growth is so far advanced when it first comes under observation that its exact origin cannot be determined.

**Etiology and Pathology.** The etiology of urethral carcinoma like that of carcinoma generally, is unknown. The majority of these growths are of the squamous-cell type the papillary and columnar cell forms being rare. Only one adenocarcinoma is noted in the 100 cases compiled by Kirwin. Urethral carcinoma occurs most frequently in the cavernous and membranous urethra—very rarely in the fossa navicularis the only portion of the canal lined with squamous epithelium. The fact that most urethral carcinomas are of the squamous cell type yet occur in a canal lined through most of its extent by columnar epithelium has led to the suggestion that they may be due either to embryonal cell nest inclusions or to metaplasia resulting in the formation of leukoplakic patches, which undergo malignant degeneration. It is common knowledge that old strictures develop nests of squamous epithelium, probably a metaplasia due to infection and irritation. There may be formation of patches of leukoplakia, which later undergo malignant degeneration.

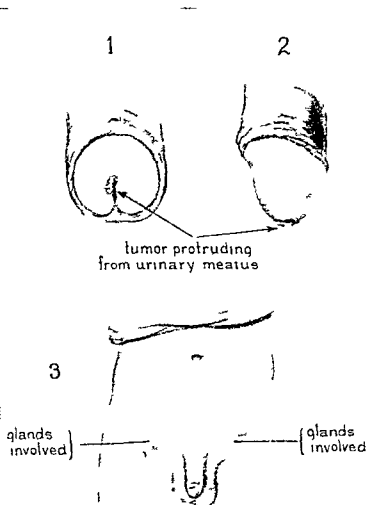
The continuous passage of infected, irritating urine over a surface already damaged by inflammation and the passage of instruments would inevitably produce a hyperplastic reaction. In at least two thirds of the reported cases there was an antecedent history of stricture (sometimes of as long as 30 years' duration) before malignancy became evident.

In urethral carcinoma, as in other carcinomatous lesions, antecedent trauma or irritation is undoubtedly a contributing factor. Thus, it is probable that carcinoma frequently develops on the site of an old stricture either gonorrheal or traumatic in origin. The growths are most likely to be found in the cavernous or membranous urethra, where stricture is most common. They are infrequent in the fossa navicularis and only an occasional case has been recorded in the prostatic portion of the urethra. Several patients in the reported cases gave a history of previous removal of benign papillomas, two had suffered damage to the tissues by foreign bodies introduced into the urethra during masturbation. Gonorrhea by inducing stricture, must be regarded as an important etiological factor. Chronic urethritis of long duration would seem likely to produce conditions favoring malignancy.

**Symptoms** As a urethral neoplasm produces partial obstruction of the lumen of the canal, the first symptoms are likely to be those ordinarily associated with stricture: difficult urination, diminution in the size and expulsive force of the stream, and straining to evacuate the bladder. Pain, except during micturition, is seldom noticeable until the condition is far advanced. If there is a preexistent traumatic or inflammatory stricture, neither physician nor patient is likely to recognize any change in the nature of the lesion. There is commonly hematuria and a purulent discharge, which may serve to direct attention to the tumor. On the other hand, in patients who have previously suffered from gonorrhea, the discharge will sometimes contain gonococci, adding further to the picture of a stricture induced by chronic urethritis.

As the disease progresses, however, and infiltrates the periurethral tissues, the patient himself may note an alteration in the size, appearance, and consistency of his penis. It feels hard and is often red and edematous. Edema of the soft parts may be so great as to simulate extravasation of urine into the scrotum and perineum. Permanent partial erection or even complete priapism may occur. Erection and ejaculation become increasingly painful until coitus, in most cases, is impossible. There is often, although not always, loss of weight, but the general condition usually remains good—so good indeed, that the clinical picture is even more clouded.

The final stage of the disease is fistula formation and infection when the clinical picture may resemble that of perineurethral abscess



Wm P D Busch 1931

FIG 127 Unusual case of primary epithelioma of the urethra confined to the distal portion of the duct with metastases to the inguinal nodes (1) End view showing the tumor protruding from the urinary meatus (2) Lateral view (3) Showing the extensive involvement of the inguinal nodes The patient was 62 years of age (Kirwin's case)

When the growth occurs in the fossa navicularis it may appear as a nodule along the course of the penile urethra or as a papillary tumor presenting at the meatus Epitheliomas of the distal portion of the urethra

therefore, are likely to be observed earlier in their course, thus permitting diagnosis at a time when treatment may yield satisfactory results

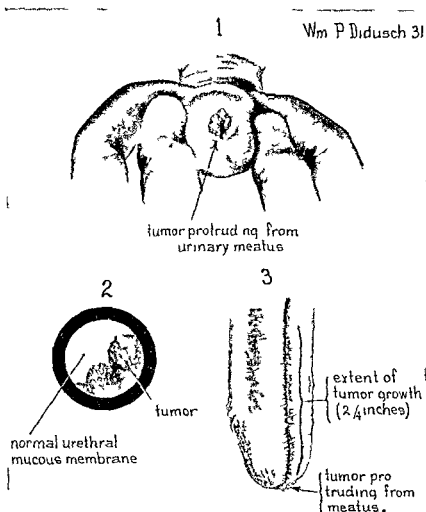


FIG 128 Epithelioma of urethra (1) The urinary meatus is spread apart to show the papillomatous mass (2) Urethroscopic view showing normal urethral membrane above and the papillomatous growth below (3) Schematic drawing of penis on longitudinal section showing extent of tumor within the urethra This patient was advised to have an amputation of the penis and transplantation of the urethra in the perineum. This he refused. The primary lesion was therefore excised with the bipolar cauterizer, the metastatic nodes extirpated and the tumor site and inguinal wounds treated first by radon implantation and later by Alpine light and deep x ray. Examination 3 months later showed slight recurrence of the tumor which was treated by cauterization (Kirwin's case)

Involvement of the inguinal lymph nodes usually occurs early. Metastasis to the pelvic nodes may occur directly without involvement of the inguinal nodes.

**Diagnosis** The diagnosis of urethral malignancy would be relatively simple were the possibility of neoplasm always borne in mind. But because of the rarity of urethral carcinoma and its resemblance, clinically, to stricture or perurethral abscess, there is grave danger of the condition not being recognized until it is far advanced. About the only prominent uniform symptom is obstruction to urination, with at times, retention. This is common to so many lesions in the urinary tract as to be of small diagnostic value. Only when the supposed stricture resists all attempts to keep it dilated when a purousanguineous discharge makes its appearance or when the character of an existing discharge changes

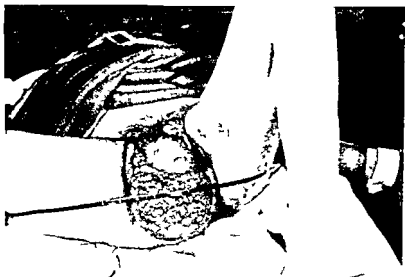


FIG. 129 Epithelioma of urethra. Photograph taken 2 years and 10 months after operation showing extensive recurrence involving the penis and scrotum. (Kirwin's case.)

radically, and when there is extensive induration and involvement of the surrounding tissues, does the physician realize that he is dealing with a far graver lesion than has been previously suspected.

Palpation and endoscopy will reveal the true nature of many cases. The diagnosis can only be positively established by biopsy, which is always warranted if done under the extreme precautions necessary in making a section from a potentially malignant lesion anywhere in the body.

Extension to the superficial and deep lying nodes is likely to be rapid and is usually evident on careful palpation the first time the patient is examined.



FIG 130 Epithelioma of urethra Low power photomicrograph showing delicate villous processes composing the core of the stroma and the transitional epithelial covering (Kirwin's case)

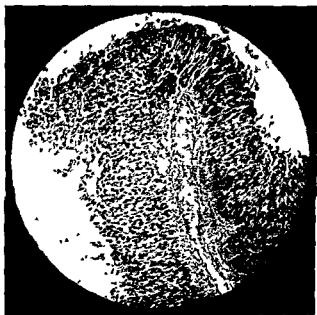


FIG 131 Epithelioma of urethra High power photomicrograph showing the comparative regularity of the epithelial cells (Kirwin's case)

**Prognosis** The prognosis differs with the site of the lesion, but is always grave, metastasis or recurrence being the rule. If metastasis to the inguinal nodes is already in evidence when the patient first comes under observation, the prognosis is poor but should not be considered utterly hopeless. The disease is, however, highly fatal, and advanced cases benefit but little from any form of treatment. If the results of treatment are to be improved, it is essential that earlier diagnoses shall be made.

**Treatment** Several types of treatment have been advocated but the results so far recorded have been very disappointing. The most satisfactory treatment appears to be complete excision of the primary growth, if possible, with extirpation of the inguinal lymph nodes when involved, followed by thorough irradiation of the inguinal areas and site of the primary tumor. Radium alone, or massive doses of roentgen ray, have been used in a few cases. Amputation of the penis may be advisable in some cases, where the growth is located in the cavernous urethra or fossa navicularis. Recurrence should be controlled by radiation (*Radiation of the Male Urethra*, p. 1742).

In Kirwin's case (Figs. 127 to 131), the primary lesion was confined to the distal portion of the urethra, but there was extensive bilateral involvement of the inguinal nodes.

#### SARCOMA OF THE URETHRA

Sarcoma of the male urethra is exceedingly rare. Campbell and Fein, reviewing the literature on all forms of urethral sarcoma in connection with the publishing of a case of melanosarcoma, in 1936, found only 11 other reports. In these, the cell structure varied considerably. Two were designated as lymphosarcoma, 2 as round cell, 1 each as spindle cell, myosarcoma, myxosarcoma, and 'sarco carcinoma'. One, described as "pigmented" was presumably a melanoma, although these authors did not regard it as identical with their own, which they reported as a "malignant melanoma" and believed to be unique.

The location of the growths also varied widely. Three were in the prostatic urethra, 1 in the membranous urethra, 2 in the bulb, 2 at the penoscrotal junction, and 3 in the penile urethra.

**Symptoms** The symptoms, course, and grave prognosis of sarcoma of the urethra parallel those of sarcoma elsewhere in the urogenital tract. In general, the symptoms resemble those of carcinoma, but sarcomas progress more rapidly and cachexia is soon evident. Metastasis, first



to the inguinal region and shortly to widely separated sections of the body, is the rule. Death from renal failure or neoplastic toxemia rapidly follows.

**Treatment** Amputation of the penis, or cautery excision of the primary lesion, with radiation by x ray and radon implantation, has been tried with some immediately favorable results, but the prognosis is always very grave.

### *Stricture of the Urethra*

Stricture of the urethra is an abnormal narrowing or loss of dilatability of any portion of the urethral lumen.

**Incidence** There has been a conspicuous diminution in both the frequency and severity of stricture of the male urethra in recent decades. More prompt and better treatment of gonorrheal urethritis and of urethral injuries—the two major causes of stricture—have resulted in a reduction of such grave sequelae as extravasations, urinary fistulas, and urethral and periurethral abscesses. Despite this improvement, however, stricture of the urethra must still be regarded as a fairly common lesion, and in clinical and hospital practice the more severe types are still relatively frequent.

**Etiology and Classification** By far the most common cause of urethral stricture is gonorrheal urethritis. Next in importance is trauma. Urethral spasm may produce a temporary stricture. Pyogenic infections, tuberculosis, and syphilis are infrequent causes of stricture of the urethra.

A convenient and commonly accepted classification is the following:

- 1 Spasmodic stricture
- 2 Congenital stricture
- 3 Acquired stricture
  - a Traumatic
  - b Inflammatory

**Spasmodic Stricture** Spasmodic stricture is due to contraction of the muscles of the deep urethra. A variety of factors may be responsible for urethral spasm: posterior urethritis or urethrocystitis, stone, rough instrumentation, irritation produced in the deep urethra by acid urine, excess coitus, masturbation, or alcoholic overindulgence. Sometimes the cause is purely psychic.

Spasm occurs only in the membranous urethra and may be very difficult to differentiate from true organic stricture at the bulbomembranous

junction Spasmodic stricture, moreover, is often associated with organic stricture, in fact, organic stricture is a common cause of spasm Urethral spasm almost always relaxes under anesthesia Cystourethrography is helpful in diagnosing spasmodic strictures Chetwood's method of differentiation is also to be recommended If a blunt instrument is held firmly against the face of a spasmodic stricture, with gentle but steady pressure, the contraction often yields suddenly and the instrument enters, causing a certain amount of pain, but if the constriction is a true stricture the resistance is firm and tight and is not suddenly overcome by the gentle pressure of an instrument larger than its caliber

The spasm can usually be relieved by hot applications, hot sitz baths, or the use of sedatives or antispasmodics Irritation of the posterior urethra may be lessened by the instillation of a soothing solution If there is much distention of the bladder, catheterization may be necessary It is essential that the physician search out the cause of the spasm, which may be mental or physical, and apply the appropriate treatment

*Congenital Stricture* Congenital strictures of the urethra are more common at the meatus, but may occur as mucous folds between the meatus and the bulb or as valvular obstructions in the prostatic urethra These have already been considered under anomalies Some congenital narrowings of the urethral lumen may be insufficient to cause urinary difficulty in childhood, but should the urethra later be impaired by gonorrhea or injury, serious aggravation of the congenital condition may result In medico-legal practice the congenital factor in such cases might well prove perplexing

*Traumatic Stricture* Traumatic strictures are caused by external or internal injury to the urethra

External violence (straddle injuries, fracture of the pelvis, bullet wounds, etc.), causing complete rupture or extensive laceration is, after gonorrhea, the most common cause of urethral stricture Unfortunately, the hazards of our machine age have increased the number of such accidents These injuries usually involve the bulbous and posterior portions of the urethra Rupture of the penis may result in stricture of the pendulous urethra

Unwise medication with caustics and strong antiseptics is a comparatively rare cause of fibrosis and stricture Stricture may also follow operation, such as transurethral resection and prostatectomy or ill advised or unskilful instrumentation

Whatever the cause of the injury to the urethra contraction of the resulting scar tissue inevitably induces narrowing of the lumen, which

must be persistently combated by dilatation if stricture is to be avoided. Traumatic strictures may develop rapidly, or may produce no symptoms until weeks or months after the injury to the urethra. They are usually extensive lesions, occurring over 1.5 to 4 cm. of the urethra. When once formed, they are much more difficult to dilate than those of inflammatory origin, and frequently require surgical excision. Prevention of stricture formation by prompt recognition and proper treatment of urethral injuries is, therefore, of the greatest importance. All victims of urethral trauma should have impressed upon them the importance of observation and dilatation at regular intervals in order to prevent sclerosis and stricture.

*Inflammatory Stricture* Approximately 90 per cent of all urethral strictures are inflammatory in origin. The vast majority are postgonorrheal. Tuberculous, syphilitic, and pyogenic infections account for a relatively small number.

Inflammatory strictures may form in any part of the canal, but usually occur in the bulbous and bulbomembranous portions—the favorite sites of chronic urethritis. Strictures of inflammatory origin are fewer and less severe in the pendulous urethra, and rarely involve the prostatic urethra.

The mucous membrane will be found indurated and thickened. Resorption of infiltrating elements deposited in the submucosal and periglandular tissues during the acute stage leads to the substitution of fibrous tissue, this, contracting, causes narrowing of the urethral lumen. That the hardening and thickening which leads to stricture is a gradual process is evidenced by the length of time that ordinarily elapses between the date when the patient has been deemed cured of his urethritis and the onset of symptoms of urinary obstruction—usually a year or more. Not infrequently years elapse before retention occurs. Once the impediment has arisen, however, the small amount of urine which it at first holds back is, nevertheless, sufficient to irritate the tissues behind the stricture, so that the process of inflammation and repair by the formation of scar tissue proceeds as a vicious circle. Even with marked retention, there will at times be found only a thin band of cicatricial tissue, in other cases, it will form a good sized irregular mass.

Such a stricture, seen through the urethroscope shows no evidence of the antecedent hyperemia and inflammation. Viewed postmortem, it will have a yellowish white color. In advanced cases, a band of scar tissue will have wholly replaced the mucosa and penetrated to the corpus

spongiosum Beyond the stricture the urethral wall will appear eroded and usually much distended

**Symptoms** The most common symptoms of stricture of the urethra are a persistent urethral discharge and some disturbance of urination Shreds are always detectable in the urine Later, with infection of the urethra and bladder, the urine becomes cloudy from pus and mucus This the patient is likely to attribute to an exacerbation of a previous gonorrheal urethritis or to a new attack Frequency of urination, decrease in the size and projectile force of the stream, difficulty, and dribbling after urination are all common complaints An acute retention may be the reason for the patient seeking medical aid

Some patients complain of painful erections Occasionally a stricture is so located as to prevent complete ejaculation of the semen, which either dribbles out of the urethra after coitus or flows backward into the bladder to be evacuated in the urine There may be decline of sexual power or even complete impotence

Dilatation of the urethra behind the stricture results in infiltration of the tissues of the urethral wall. Rupture with extravasation infection, and urinary fistulas is the serious and not infrequent sequel

Remoter complications are the changes in the urogenital tract due to back pressure and infection In stricture with chronic posterior urethritis, the prostate and glandular adnexa are almost always involved, Though the stricture is seldom so tight as to cause complete retention, with strictures of small caliber the stream is frequently reduced to a mere thread Residual urine is almost constant Long continuance of the strictured condition eventually produces cystitis, and in the absence of treatment, may cause irreparable damage to the upper urinary tract

**Diagnosis** The diagnosis is based upon the history, physical examination and instrumental examination of the urethra Cystourethrography, used alone or in conjunction with other methods is a valuable aid in the diagnosis and location of urethral strictures particularly in patients with small caliber or impenetrable strictures in whom instrumentation is difficult or impossible In addition to demonstrating the location, number, and extent of the strictured areas it has the added advantages of differentiating spasmodic from organic strictures and of delineating associated pathological lesions of the urethra and its adnexa, such as submucosal and glandular dilatations prostatic abscesses and fistulas

Instrumental examination determines not only the presence of stric

ture, but its location, size, and type. The instruments required are bougies à boule, whalebone filiforms, Phillips woven silk whips, olive tipped catheters and bougies, and conical sounds. These instruments, as well as the preparation of the patient and the technic of instrumental examination, have already been considered in the chapter on Instrumental Examination (Urethral Exploration, p. 71). For observing the surface appearance of the urethral mucosa, the cysto urethroscope is of distinct advantage.

As in any disturbance of the lower urinary tract, a careful routine examination should be carried out before instrumental exploration is undertaken. This consists of inspection and palpation of the external genitalia, rectal palpation of the prostate and vesicles, examination of the urethral discharge, and physical and laboratory examination of the urine. Such investigation should reveal any associated lesions and complications, such as chronic urethritis and the changes in the urogenital tract due to urinary back pressure and infection, which must be correlated with the findings of instrumental exploration.

**Treatment.** Two methods of treatment are available: (1) gradual dilatation, (2) surgery.

(1) *Dilatation.* Needless to say, surgery should be avoided whenever possible, and in the great majority of cases patience on the part of both doctor and patient will obviate the necessity of operation. But even in cases where operation is necessary, dilatation becomes an essential adjunct if permanency of cure is to be maintained. Dilatation, aside from the mechanical stretching produced, leads to a certain amount of resorption of scar tissue. The greater the degree of this resorption and softening, the better, of course, will be the end result. The effect produced by the sound, in the gradual stretching of the hardened tissues, is not unlike that produced by massage on cicatricial areas on the external surface.

*Dilatation is accomplished with filiforms and followers, conical sounds, graduated bougies, and Kollmann dilators.*

In acute retention, filiforms and followers, if properly used, will, as a rule, obviate the necessity of cystotomy or perineal urethrotomy. Many cases of apparently impenetrable stricture may be successfully dilated by using the Lowsley forward looking urethroscope (p. 90) for the purpose of introducing filiforms under direct vision, thus saving the patient a major operation.

For progressive dilatation, conical sounds are used at carefully spaced

intervals Sometimes dilatation is begun with filiforms attached to followers, by means of which the caliber of the largest sound capable of passing can be determined The first sound employed should be capable of slipping into the bladder practically of its own weight Force should never be used If the first sound selected will not pass, insert a smaller one Not more than two sizes of sounds (or followers) should be inserted at the first session, and about 3 days should be allowed to elapse before the next treatment Further dilatation is accomplished by gradually increasing the size of the sounds never using more than two or three successive numbers of the caliber scale at any one session It may be advisable, at each treatment, to start with a sound a size smaller than that last passed As the lumen of the urethra gradually increases in caliber, and the tendency to contract after dilatation is more and more overcome, the time between treatments should be gradually extended

The length of time dilatation must be continued varies with the individual patient In general, if the urethra can be dilated so that it will readily receive a No 25 to 30 F sound after an extended interval of non intervention, the result may be considered good

The Kollmann dilator may prove useful after the lumen has been increased by sounds to No 28-F or more, but if used too early, it is likely to cause injury to the urethra that will defeat its own purpose The object in dilating the constriction is to cause a necrosis of the hardest fibers by damage so slight that it will be repaired, not by scar tissue, but by absorption—thereby lessening the constriction

At first, dilatations should be carried out every 5 days Later (according to the tendency of the stricture to recur) the interval should be extended to a week, 2 weeks 4 weeks 6 weeks 3 months, 6 months, and finally once a year, but a patient who has had a 'filiform' stricture at any time in his life must count on having his urethra dilated at least once annually

Dilatation by promoting drainage usually helps in the elimination of infection, but where there are associated lesions supplemental treatment must be directed to these

(2) *Operative Treatment* Surgical treatment consists of meatotomy, internal urethrotomy, external urethrotomy, and cystotomy These, and the indications for their performance, are considered under Operative Treatment of Stricture of the Urethra (p 673)

As a rule, surgical treatment should be reserved for those relatively

infrequent cases where the strictured area is too extensive or the stricture too tight to admit of dilatation, or where dilatation has been unsuccessful or is poorly borne, or where complicating factors, such as extravasation, suppuration, or fistulas, exist. In general, meatotomy is indicated in strictures of the external meatus, internal urethrotomy in strictures of the anterior (pendulous) urethra, and external urethrotomy or cystotomy in strictures of the bulbous or membranous urethra.

No matter what surgical treatment may be employed, dilatation constitutes the main feature of the after treatment.

### *Acquired Diverticulum of the Urethra*

**Etiology** Acquired diverticula occur mainly in the posterior urethra, and the chief causes—calculus, stricture, rupture of a periurethral abscess or cyst into the urethra, and traumatic perforation of the urethral wall—are more common in adults. Congenital diverticula, on the other hand, usually occur on the ventral wall of the anterior urethra, and frequently give symptoms in infancy or early childhood (Congenital Diverticulum, p. 625).

Stone is a fairly frequent finding in connection with urethral diverticula. Calculi may form, or lodge, in a congenital diverticulum, or may themselves be the cause of the saccular formation. Acquired diverticula due to stone are usually located in the perineum or the pendulous urethra. Congenital valves or urethral stricture may cause such dilatation of the urethra as to result in permanent pouches above the obstructed area. A diverticulum may be formed by the rupture into the urethra of a periurethral abscess or a cyst (such as a retention cyst of a Cowper's gland duct) and persistence of the fistulous opening with dilatation of the duct behind it. Other diverticula arise from perforation of the urethral wall by external trauma or improper instrumentation.

**Symptoms and Diagnosis** The onset of symptoms is generally insidious. Small diverticula may cause no disturbance. When medical advice is sought, it is usually for difficult urination and a fluctuating tumor in the perineum, scrotum, or penis. The most common complaints are of terminal incontinence, decreased expulsive force of the stream, and the increased length of time required for micturition. Irregular symptoms are total incontinence and pyuria. Most diverticula are so located as always to contain urine, which decomposes and leads to disorders of the urinary tract. Pressure of the filled pouch on the ure-

thral lumen produces dilatation infection and pathological changes in the urinary tract above the obstruction Symptoms of prostatitis and cystitis are common

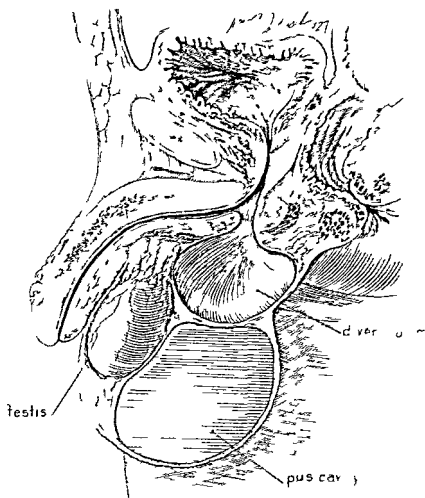


FIG. 132. Sagittal section showing a large diverticulum of the urethra. In the lower part of the scrotum is a large cavity containing pus; this has displaced the testis anteriorly.

As a rule a urethral diverticulum is readily recognized by the urinary difficulties it causes and the detection of a fluctuating mass near or upon the penis. This subsides when pressed upon, the retained urine being thereby wholly or partially evacuated. When not distended with urine,



the sac is usually soft and pliable, but when filled, it appears as a firm, tense mass. Of the 115 cases of urethral diverticula studied by Lowsley and Gutierrez (109 collected from the literature and 6 observed personally), 61 of the diverticula were located in the anterior urethra and 54 in the posterior urethra.

The orifice of the diverticulum may be plainly seen through the urethroscope, and urethrography will give further information regarding its location and size and the associated lesions.

**Prognosis.** If the diagnosis is made before serious injury has been done to the bladder and upper urinary tract by back pressure and infection, the prognosis is good, and excision of the sac is usually followed by complete relief of the symptoms.

**Treatment.** Small urethral diverticula are not infrequently discovered when exploring for other purposes, having never caused the patient any inconvenience. These are sometimes better left alone. Large and obstructive diverticula require radical resection. The earlier the diagnosis and surgical intervention, the less the danger of irreparable injury to the upper part of the tract through urinary stasis and infection. Complete excision of the sac and reconstruction of the urethral wall is the preferred treatment, and can be performed with relative ease (*Excision of Urethral Diverticulum*, p. 691).

### *Urethral Calculus*

**Etiology.** Most urethral stones have formed higher up in the urinary tract and lodged in the urethra. A small stone expelled from the bladder may lodge in an irregularity of the urethral wall, which it quickly enlarges by pressure and accretion. Primary stones of the urethra are less common and are usually caused by urinary stasis such as occurs with prostatic hypertrophy, abnormal dilatation of any portion of the canal, stricture, and diverticula where urine may remain for long periods, gradually concentrating until a concretion forms. Stone and diverticulum are frequently associated, but whether the stone is a cause or a result of the sacculation may be impossible to determine. Prostatic stones may rupture through into the urethra. The chemical state of urine plays an important part in the formation and composition of urethral stones.

Urethral calculi are as a rule solitary, but very large collections of stones have occasionally been reported.

**Symptoms.** The symptoms vary according to the location of the

stone and the degree of obstruction and irritation it produces. The formation of stone in a congenital diverticulum may be a lengthy process,

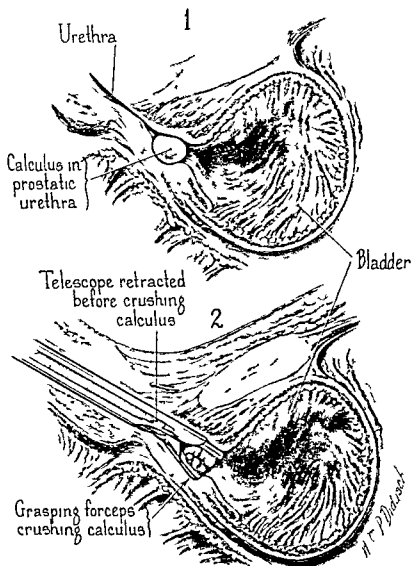


FIG. 133 Removing a stone from the prostatic urethra with the Lowsley grasping forceps and calculi in congenital diverticula may remain a long time without producing symptoms

The symptoms of urethral calculus are more likely to appear gradually,

and usually have been in evidence for some time when the patient seeks medical aid. Evidences of stone in the urethra are decrease in the size and expulsive force of the stream, dribbling or steadily increasing incontinence, retention, and pain. The pain is often felt only on assuming some particular position, and is sharp and radiating. Stones in the prostatic urethra are usually the most painful, the pain being felt in the perineum, rectum or sacrum. Often the patient has been aware of a "lump" in the penis for some time, but seeks medical advice only after it has caused suffering or serious inconvenience. In one case the stone was known to have been present for 53 years (Hirsch), and in another for 23 years (Galbraith). Unrecognized calculi may induce periurethritis, with subsequent suppuration and formation of a fistula.

**Diagnosis** A careful history, simple palpation of the penis and rectal palpation are often sufficient to give presumptive evidence of stone in the urethra, and confirmation can be obtained by urethroscopy and, if necessary, by urethrography after the injection of an opaque medium.

**Treatment** Treatment depends upon the size and location of the stone and on the state of the urethra. Removal of the stone through the urethroscope is frequently possible. Small stones in the anterior urethra may sometimes be milked out and the urethra irrigated with mild antiseptics. Gradual dilatation with sounds may permit passage of a movable stone. Stones firmly embedded in diverticula will seldom emerge without assistance. They can sometimes be reached through the urethroscope and withdrawn with forceps without injury to the urethral wall. The sac can then be destroyed by diathermic methods. Occasionally, small diverticula containing fine stones may be emptied of their content and stretched by gradual dilatation until they are incapable of retaining anything.

External urethrotomy is sometimes necessary, but should be employed only when more conservative measures fail. The surgical removal of urethral calculi is further described and illustrated under Operative Treatment of Urethral Calculus (p. 696).

#### *Diseases of the Urethra in Children*

Most of the urethral irregularities encountered in male children are congenital deformities: hypospadias, epispadias, valves of the posterior urethra, stricture of the meatus and congenital diverticulum. These have already been discussed.

Male children are not often afflicted with urethritis. Gonorrhea in children has a decided proclivity for the female sex.

Urethral neoplasms in children have been reported in rare instances. A few cases of polyps are on record, and a case of sarcoma in an infant aged 8 weeks (Puhl). Herbst has seen a case of fibrosis at the vesical neck in an infant dying of uremia at the age of 9 months.

Urethral calculus occasionally occurs in children.

The treatment of these conditions in children does not differ from that in adults.

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## CHAPTER XXI

### OPERATIVE TREATMENT OF THE MALE URETHRA

A large proportion of urethral interventions are done intraurethrally, and are either office procedures or require only a brief hospital sojourn. General anesthesia is rarely necessary except for children, and the routine preparation is, in general, that employed in office examination or cystoscopy.

#### *Preoperative Preparation*

The urethral canal should be well irrigated with a mild antiseptic normal saline solution, boric acid, 4 per cent, argyrol, 2 per cent, or potassium permanganate, 1 4,000. Methenamine, or other urinary antiseptic, should be administered orally for several days before operation.

For intraurethral procedures, the preparation is the same as for cystoscopy or urethroscopy.

For open operations, the external genitals and perineum are shaved, cleansed with warm water and tincture of green soap, and sprayed with tincture of zephuran, 1 1,000. Tincture of merthiolate, 1 1,000, or other skin sterilizing solution.

The patient's bladder should be kept well filled with sterile water or other distending fluid so that its location may easily be made out and its entrance recognized by the fluid escaping from it into the urethral canal.

#### *Position of Patient on Operating Table*

For most urethral procedures, the patient lies on his back with the thighs well separated. For external urethrotomy, he is placed in the lithotomy position. One of the special tables designed for prostatectomy is utilized if available.

#### *Anesthesia*

Most operations upon the urethra are now done under spinal or sacral anesthesia, although some surgeons still prefer a general anesthetic for such a procedure as external urethrotomy. For operations within the urethra, local anesthesia with cocaine derivatives is widely employed. Pentothal sodium, administered intravenously, is useful for a short procedure. For children, general inhalation anesthesia is preferable.



All of these methods are discussed in the chapter on Anesthesia in Urology (p 190)

### *Operative Treatment of Stricture of the Urethra*

#### MEATOTOMY

**Indications** Meatotomy is imperative in all cases of congenital stenosis of the urinary meatus. Enlargement of a small meatus (No 26 F or less) is frequently necessary in cases of persistent or recurrent *non specific or specific urethritis*, and for the satisfactory passage of cystoscopic or urethroscopic instruments. Gradual dilatation is the best method of accomplishing this, but often the necessary delay is not possible.

**Technic of Meatotomy** The meatal lips are formed of the cavernous tissue of the glans, and are joined above and below by membranous commissures. As a rule, meatotomy is best done by slitting the bottom commissure.

**Local infiltration anesthesia** is usually sufficient for an adult or older child. General anesthesia is preferable for an infant. The preparation of the field is the same as for circumcision (p 319).

A fine scalpel is introduced for a distance of 1 cm within the meatus. The lower surface of the urethral mucosa is then incised, the cut being carried through the glandular substance until the inferior surface of the glans is reached. A glass bougie ( $\frac{1}{8}$  inch in diameter tapering to  $\frac{1}{16}$  inch) is immediately inserted, and if this does not easily pass, the incision is carried a little higher up the urethra. Any slight bleeding is easily controlled by digital pressure. The cut edges are held apart by a stitch inserted on either side, this passes from the urethral mucosa through the glans and along the corona, and is tied on the outside of the glans.

Complete healing should take place in 4 or 5 days. Thereafter, the meatus should be dilated twice daily with a glass bougie of the same *size and shape as that inserted at operation*. The infant's attendant (or the patient, if old enough to cooperate) should be provided with the rod and instructed in its use.

**Meatotomy, with Suture of Cut Edges** Ballenger, Elder and McDonald advocate suturing of the cut edges, which they claim does away with the necessity of passing sounds to keep the meatus open while healing, and makes for better cosmetic and final results. Their technic is as follows

Preliminary to infiltration with novocaine,  $\frac{1}{2}$  ounce of a 1 or 2 per cent solution of novocaine is injected into the urethra and held for 2 or

3 minutes The mucous membrane is thus partially anesthetized, so that the needle puncture can be made just within the meatus through the mucous membrane with less pain than through the skin The addition of a drop or two of adrenalin solution to the novocaine lessens the bleeding and thus facilitates suture The meatus is lengthened to the desired size by incising its lower end (occasionally the upper commissure) with a fine scalpel The first sutures are placed at the outer edges of the cut catching only the skin and mucous membrane in the sutures The deeper part of the mucous membrane may be reached more easily if the second or third stitches are temporarily left long so that they can be used as retractors to open up the meatus and expose the inner margin of the mucous membrane The sutures buttonhole the cut edges preventing their re adhesion and making the postoperative use of sounds unnecessary

### INTERNAL URETHROTOMY

**Indications** Internal urethrotomy is necessary in those comparatively infrequent cases where a stricture of the *pendulous urethra* is too dense or too resilient for dilatation where dilatations are poorly borne where economic reasons deter the patient from the lengthier non operative process or where complications make immediate restoration of the urethral caliber imperative

**Urethrotomes** **Technic of Internal Urethrotomy** There are several types of urethrotomes available but the ones most often used are the Maisonneuve and the Otis If the stricture is very tight (less than No 13 F) the Maisonneuve urethrotome must be employed

The main shaft of the Maisonneuve urethrotome is a rather fine rod with a curve similar to that of a sound There is a groove upon the concave side along which slides a tiny knife shaped like a glazier's point and attached to a fine handle by which it is manipulated The urethrotome is attached to a filiform which is so held that the groove of the urethrotome faces the median line of the dorsum of the penis When the instrument has passed the stricture the knife is fitted into the groove provided for it and the strictured area incised

The Otis urethrotome has a dilating feature lacking in the Maisonneuve instrument This acts in much the same way as do the mechanical dilators With this instrument it is possible to dilate the stricture as it is being cut The urethrotome consists of two parallel bars which can be separated by manipulating a thumb screw on the handle and

are supported by the elevation of smaller, horizontal bars as the main bars are separated. The upper parallel bar has a groove through which knives of various sizes may be slipped. The instrument is introduced closed and pushed up the urethra until its tip has passed the stricture. With the blade exactly in the upper median line, the thumb screw is turned so as to separate the bars as far as possible without tearing the tissues, which should only be rendered tense enough to facilitate division of the stricture. With its sharp edge against the urethral roof, the knife is now drawn forward and the stricture divided completely. The blade is then drawn back to its groove and the bars separated still further. If the characteristic resistance is still felt, division of the stricture is incomplete and further cutting is necessary.

A stricture may be incised from its anterior edge toward the bladder, or the urethrotome may be passed beyond the strictured area and then drawn back toward the meatus, severing the stricture from its vesical toward its meatal aspect.

**After-care** Following internal urethrotomy, pains must be taken to assure open healing of the cut, otherwise there will be no enlargement of the urethral lumen. This is accomplished by the passage of sounds at intervals of 4 or 5 days. The first sound passed postoperatively (on about the fourth day) corresponds to the caliber of the dilated canal, and the surgeon endeavors to maintain this caliber until healing has taken place.

### EXTERNAL URETHROTOMY

**Indications** External urethrotomy is necessary when the stricture is impassable, and is regularly used for permeable strictures located as far back as the subpubic ligament which cannot, for one reason or another, be subjected to dilatation. External urethrotomy (or cystotomy) is also necessary when the stricture is complicated by extravasation, abscess, sepsis, or fistula.

**Perineal Section Without a Guide** Stricture of the urethra due to bacterial causes is seldom extensive. The narrowing occurs over a short distance as a rule, and usually in the bulbous and bulbomembranous portions of the urethra. In such strictures, if insertion of a guide is impossible, it is our practice to place the patient squarely upon the table, then, with a hollow backed sound in the urethra, a perineal section is made, the urethra opened in its bulbous portion and the incision extended to a point directly under the symphysis pubis in the mid

line, because this is always a fixed portion of the urethra. The prostatic urethra behind the stricture is always dilated, and if the urethra is opened under the symphysis the operator will be able to insert his finger or the instrument into the dilated portion and thence into the bladder. The Otis urethrotome can then be introduced and incision made in the urethral wall in the strictured portion, and sounds up to No. 28 F. passed. The bladder is drained by a tube extending through the perineal wound. This is removed 5 or 6 days after operation and sounds immediately passed.

**External Perineal Urethrotomy with a Guide.** If the stricture is not too tight, the regular grooved staff may be employed at the outset, otherwise a filiform must first be introduced. The instrument is passed all the way to the bladder so as to make sure that it has not entered a false passage.

While an assistant holds the staff so that the groove is readily palpable through the perineum, the knife is inserted about 4 cm. anterior to the anus and its point drawn backward along the groove in the director until it impinges upon the membranous urethra—a distance of from 1 to 2 cm. The incision should be large enough to permit entrance of the operator's finger. With the finger in the wound, the staff is withdrawn. The finger can now be passed back through the urethra and into the bladder. Abscesses, calculi, or other pathological conditions can be felt by the exploring finger, and it can be determined whether or not the stricture has been completely severed. Should the incision not be large enough to permit passage of the finger, a grooved director must be inserted through the perineum and the strictured area incised still further upon it. A rubber perineal tube is inserted into the bladder and stitched to the wound. It is usually removed after 5 days.

**After-care.** Following external urethrotomy, the urethra must be dilated at stated intervals over a period of many months, as scar tissue tends to shrink long after the wound is completely healed.

### RESECTION OF STRICTURED AREA

**Resection of Extensive Stricture in the Membranous Urethra.** Radical resection of the strictured area is sometimes necessary in extensive strictures of the membranous urethra—usually of traumatic origin. This we do as follows:

The patient is placed on the table in the lithotomy position. A guide is passed into the urethra as far as it will penetrate. An inverted V

incision is then made in the perineum and deepened until the membranous urethra is exposed. All of the cicatricial tissue, no matter how

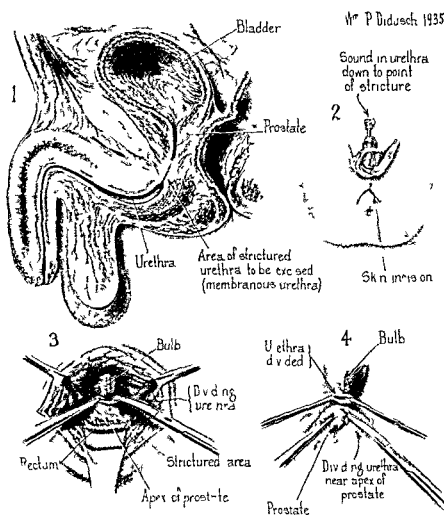


FIG. 134 Resection of extensive stricture of the deep urethra. (1) Sagittal view, showing dense impermeable stricture of the membranous urethra. (2, 3) A sound is passed down to the stricture, the membranous urethra exposed through an inverted V incision in the perineum and the urethra divided near the bulb. (4) Dividing the urethra near the apex of the prostate.

extensive, is excised. The cut ends of the urethra are anastomosed with chromic catgut, the sutures being placed anteriorly only. A small rubber tube is inserted into the bladder and extends out through the

perineal wound, which is closed in layers, plain catgut being used for the musculature and silk worm gut for the skin

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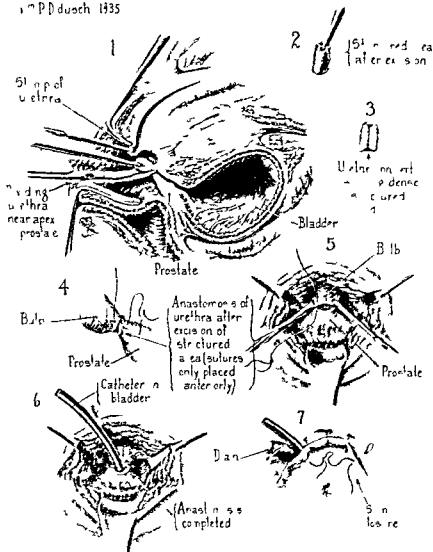


FIG. 135. Resection of extensive stricture of the deep urethra. (1, 2, 3) Completing resection of the structured area. (4, 5, 6) Anastomosing the cut ends of the urethra. (7) Final skin closure.

**Electrosurgical Resection of Structured Area** Certain types of stricture are successfully handled by the resectoscope. Hemorrhage is

usually slight, and the formation of septic foci practically never occurs, the sealing off of the blood vessels preventing septic absorption

The stricture should be dilated as much as possible before the resectoscope is introduced. The procedure is otherwise similar to that described on page 915 for resection of the prostate. The postoperative care is very simple. A catheter is left in the urethra for a few days, daily irrigations are given, and urinary antiseptics administered orally to aid in warding off infection.

### *Operative Treatment of Ruptured Urethra*

Most cases of rupture of the male urethra fall into one of two major groups: (1) the so called "straddle injury," in which the bulbous urethra is wholly or partially severed and there are associated perineal injuries, (2) injury, usually of the posterior urethra, with fracture of the pelvis.

#### TREATMENT OF RUPTURE WITHOUT PELVIC FRACTURE

Treatment of "straddle" and other injuries uncomplicated by pelvic fracture varies according to the extent and condition of the lesion.

**Drainage of Bladder and Extravasated Areas** Of first importance is the prompt institution of bladder drainage, to prevent leakage into the surrounding tissues, or, if such leakage has already occurred, ample drainage of all extravasated areas, to control infection and lessen scar-formation, sclerosis, and stricture. In such injuries there is likely to be extensive perineal ecchymosis and formation of a large hematoma. Free incision is frequently necessary, to evacuate blood clots and extravasated urine. If ample drainage, both suprapublically and perineally, is provided and maintained, the tears and ruptures usually take care of themselves unless the urethra is completely severed, in which case it is necessary to suture only the roof of the urethra. Too much suturing in these soft, contused, ecchymotic tissues defeats its own purpose. Stricture is a common sequel of ruptures of the bulbous urethra. Ample drainage and early dilatation of the urethral lumen, with continued attention over a long period, lessen sclerosis and stricture formation.

**Repair of the Urethra** Opinions differ in regard to the advisability of immediate repair of the urethra. If the patient's condition warrants, early repair should be done. Occasionally, if a catheter can be passed, a partially ruptured urethra may be "splinted" upon it and may heal without further interference. Usually, however, the passing of a catheter

ter is impossible. Under these circumstances, the most common treatment is perineal urethrotomy with suture of the torn edges over an indwelling catheter.

Great difficulty may be experienced in locating the severed ends. A sound passed through the meatus will show the location of the distal end, but finding the posterior end is not always easy. Compression of the bladder by abdominal pressure, and observation in the perineal wound of the source of urine, will sometimes localize it. If not, retro-

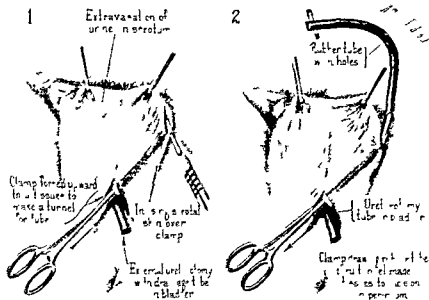


FIG 136 Extravasation of urine. Drainage of the scrotum.

grade catheterization (after suprapubic cystotomy) is the usual method of accomplishing this. A sound passed through the vesical sphincter downward will demonstrate the location of the posterior end of the urethra. Both ends having been located, the urethra can then be repaired by an anastomosis of the severed fragments, suprapubic drainage being maintained until healing has taken place.

Another method of repair quite frequently employed is as follows. Extraperitoneal suprapubic cystostomy is first performed. A male sound is introduced through the meatus and advanced toward the site of rupture. A female sound is passed through the cystostomy wound into the vesical sphincter and advanced into the posterior urethra (being



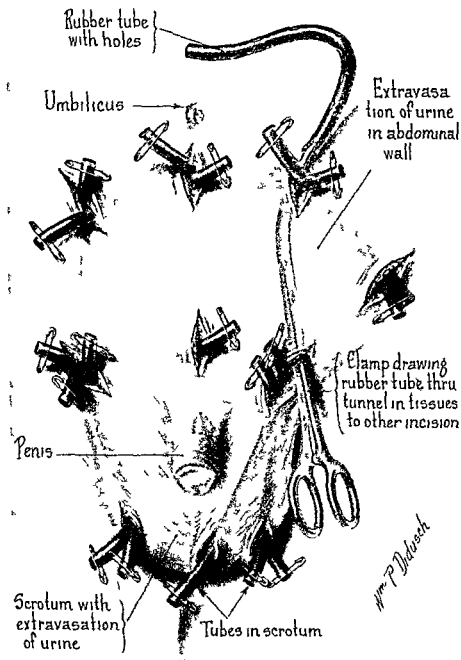


FIG 137 Extravasation of urine. Multiple incisions in abdominal wall and scrotum for free drainage of the extravasated region. The rubber tubes are drawn from one incision to another by a clamp.

guided by gentle downward and forward pressure) until it can be fitted over the male tip. The female sound is then gently withdrawn from the bladder, thus leading the male sound through the vesical neck and

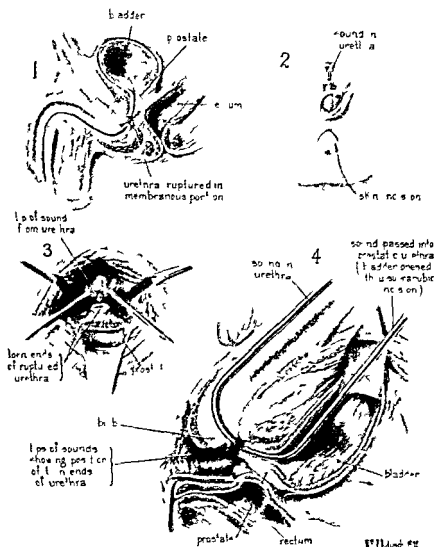


FIG. 138. Operation for rupture of the urethra. (1) Sagittal view showing the urethra ruptured in the membranous portion. (2) A sound is passed down to the rupture and an inverted Y incision made in the perineum and deepened to expose the membranous urethra. The tip of the sound can be seen in the severed distal end of the urethra. (4) Sagittal view illustrating the technic used when the lumen of the proximal end cannot be located. A suprapubic incision is made and a sound passed through the vesical orifice and prostatic urethra, showing the location of the proximal end of the urethra.

into the bladder. The lower end of the male sound is now covered by a soft rubber catheter which is stitched tightly so as to preserve the taper of the sound, thereby facilitating its passage through the damaged portion of the urethra. When the catheter has been brought into the blad-

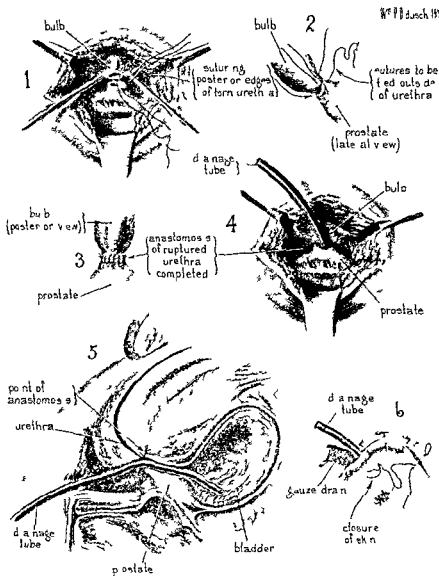


FIG. 139. Operation for rupture of the urethra. (1, 2, 3) Suturing the torn ends of the urethra. Only the posterior edges are sutured. (4) View through the perineal wound showing the anastomosis completed. The anterior wall is not sutured. A rubber tube or catheter is inserted for drainage. (5) Sagittal view of the completed anastomosis. (6) Final skin closure.

der by gradual withdrawal of the male sound, the torn urethra will have been "splinted" upon it. The vesical end of the catheter is closed to prevent the passage of urine, which should be evacuated through the regular suprapubic tube for from 4 to 7 days. At the end of this time the urethral catheter is opened up, the bladder irrigated, and the suprapubic tube removed. Evacuation of the bladder now takes place through the urethral catheter, which is left in place until the suprapubic fistula has completely closed—usually about 2 weeks after the original cystostomy.

Regular dilatations should be carried out for some time subsequent to operation, to insure against the formation of stricture.

#### TREATMENT OF RUPTURE COMPLICATING PELVIC FRACTURE

There is grave danger, as H. W. Martin has pointed out, in placing a patient with a fractured pelvis complicated by urethral rupture in the exaggerated lithotomy position. For straddle injuries a perineal exposure is desirable, and can generally be obtained without danger, but in crushing injuries with bone fracture the situation has a different aspect. It is impossible to tell what damage may be inflicted by loose spicules of bone if the patient is placed in the exaggerated lithotomy position, and if the lithotomy position is not exaggerated the exposure is poor. If the sacroiliac synchondrosis is so injured that there is slipping, with extensive ecchymosis and discoloration, all of which is common in crushing injuries, it may be so difficult to identify tears and punctures that suture will be impossible. That suture is often unnecessary, and that the imperative nature of primary repair has been overstressed, is the opinion of this experienced surgeon with which we are in accord.

Drainage of the bladder and of any extravasated areas is of first importance. Since the ruptured urethra is only part of the general trauma the less manipulation the better. After the patient has recovered from the shock and immediate danger, operation for repair of the urethra may be required. As these cases are hardly ever twice alike, the best surgical judgment is necessary in order to select the operative procedure best suited to the condition at hand.

When many blood vessels have been ruptured, it may be necessary to evacuate fluid and clots by the perineal route. An inverted V incision is made in the perineum exposing the membranous urethra and permitting a search for the fragments. If the prostate has been torn away, it may be grasped and drawn down toward the perineal wound so that the two ends of the urethra are approximated. A catheter passed

through the meatus will emerge from the lower fragment and may then be guided into the upper fragment, through the prostatic urethra, and into the bladder. The severed ends can then be anastomosed over the catheter.

Occasionally, great difficulty in finding the ends may be encountered. Wide exposure by suprapubic cystostomy will then be necessary, with the passage of catheters in both directions (through the meatus upward and through the vesical sphincter downward) so that the tips of both catheters will be visible at their points of emergence.

In neglected cases, the urethra may be entirely obliterated and replaced at the point of injury by a mass of cicatricial tissue. The outlook in such cases is gloomy, for even if continuity of the urethra may be reestablished, the patient is almost certain to remain impotent. The dangers of impotence should constantly be kept in mind when deciding upon the course of treatment to be followed. If the blood vessels and nerves are already badly traumatized, the surgeon should take care not to make matters worse by injudicious intervention.

In very extensive crushing injuries, with pelvic fracture, a recto-urethral fistula may eventuate. This and other complications, such as secondary stricture, may require subsequent operation (*Recto Urethral Fistula*, p. 694). Secondary strictures of the prostatic and membranous portions of the urethra are, however, rare in comparison with those occurring in the bulbous portion.

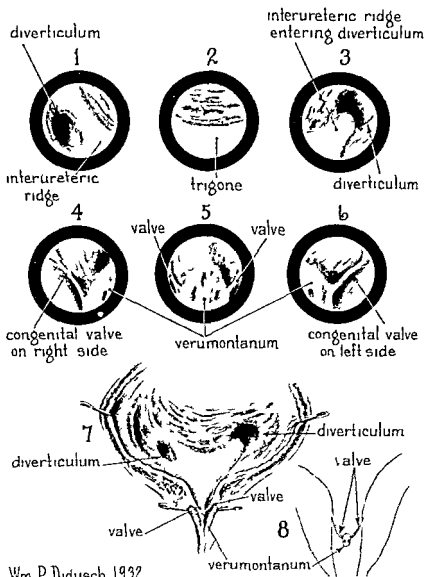
**After-care** After treatment in cases of urethral rupture is extremely important. All victims of urethral trauma should be warned of the possible aftermaths of sclerosis and secondary stricture, and urged to persist in preventive measures. Regular dilatations should be carried out for some time after operation, to prevent formation of stricture. Observation should be continued for at least a year.

#### *Operative Treatment of Congenital Valves of the Posterior Urethra*

In the treatment of congenital valves of the posterior urethra various methods have been followed. The earlier operations were usually external perineal urethrotomies with excision of the obstructing tissue, but most reports of the use of the perineal incision do not indicate that this approach is advisable. Perfecting of the urethroscope permitted intraurethral extirpation, and, more recently still, the various instruments designed for removal of obstruction at the vesical neck have been utilized for the treatment of urethral valves.

In our practice, the Kirwin resectoscope (p. 913) has proved very

satisfactory for this purpose. The operation is a simple one, requiring only a short stay in the hospital, and even very small children can be



Wm P Didusch 1932

FIG. 130. Resection of congenital valves of the posterior urethra with the Kirwin resectoscope. Showing the condition present. (1 to 6) Cystoscopic views of the trigone and prostatic urethra showing the vesical pathology and the verumontanum with the congenital valves. (7) A reconstruction of the cystoscopic findings. (8) Diagram illustrating the construction of the valves.

entirely relieved in this manner. In infants, the urethral caliber may be too restricted to admit any resecting instrument. It may then be

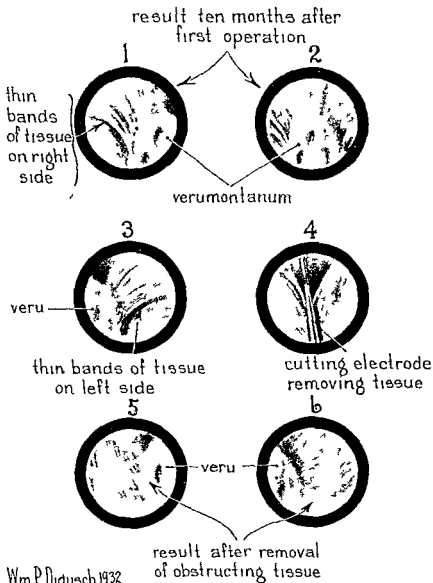
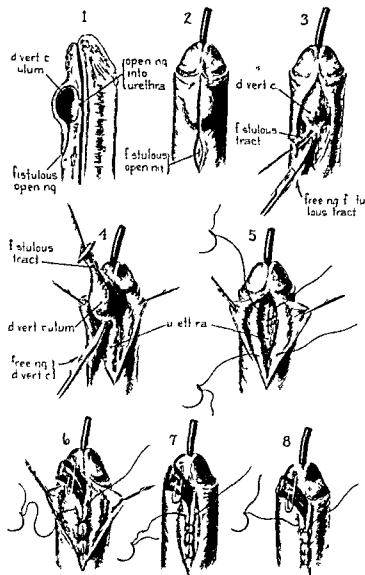


FIG. 141. Resection of congenital valves of the posterior urethra with the Kirwin resectoscope. (1, 2, 3) Showing the result 10 months after the first operation. (4) Resecting the thin band of obstructing tissue remaining. (5, 6) Result after removal of the obstructing tissue on both sides of the verumontanum.

necessary to perform the operation through one of the baby cystoscopes, such as that designed by Butterfield.

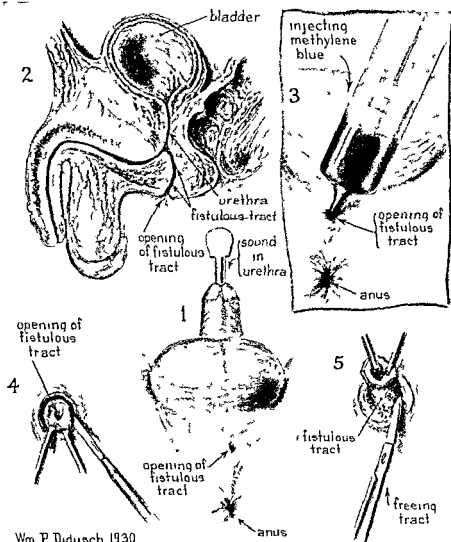


Wm PD Busch 1929

FIG 142 Excision of diverticulum of the anterior urethra (1) Condition on section showing opening into the urethra and a fistulous opening on the penile surface (2) A catheter is inserted into the urethra and an incision made over the diverticulum and around the fistulous opening (3 4) The fistulous tract and the diverticulum are freed and dissected out (5) The mucous membrane of the urethra is turned in by three interrupted catgut sutures and a drain placed over this (6) Suturing the deep fascia of the penis (7) Suturing Buck's fascia (8) Final skin closure



Proper preoperative treatment is usually as important as suitable operative measures—indeed, without the first the second has small chance of being effective. Such measures include gradual decompression



Wm P Didusch 1930

FIG 143 Excision of urethroperineal fistula (1) Perineal view of orifice of fistula (2) Sectional view, showing fistulous tract from membranous urethra to the perineum (3) Injecting methylene blue into the fistulous tract (4) Making an incision around the fistulous opening (5) Freeing the fistulous tract

by indwelling catheter (rarely, suprapubic cystostomy), forcing of fluids, urinary antiseptics by mouth, and careful observation of renal and circulatory function

**After-care** These patients should be kept under regular postoperative observation for an indefinite period. After the valves have been

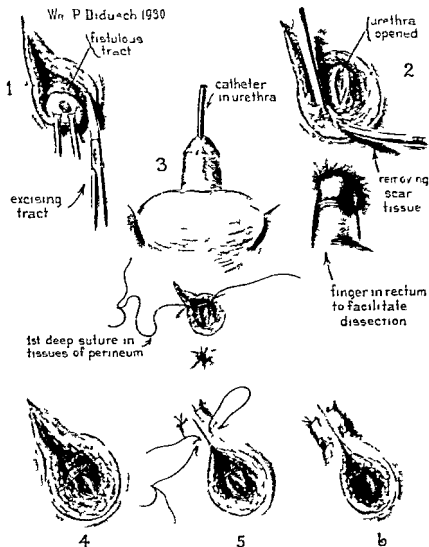


FIG 144 Excision of urethroperineal fistula (1) Excising the fistulous tract. (2) Removing the scar tissue with the finger in the rectum (3 to 6) The urethra is closed with interrupted chromic-gut or silver wire sutures turning the mucous edges well inward and the skin repaired by interrupted silk sutures

removed, treatment of secondary changes—such as angulated hydro-ureters, which in themselves are obstructive factors—is frequently required

*Excision of Urethral Diverticulum and Repair of Urethral Wall*

**Technic** An incision is made over the mass of the diverticulum, deepened and the diverticulum freed and removed (Fig 142) The mu

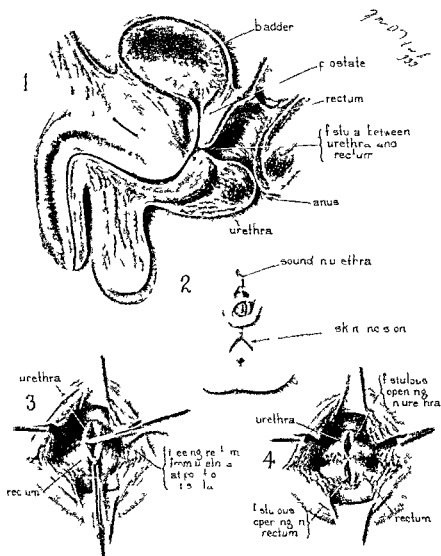


FIG 145 Operation for repair of recto urethral fistula (1) Sagittal section showing the condition (2) With the patient in the lithotomy position a sound is passed into the urethra and an inverted V incision made in the perineum (3) The perineal tissues are separated down to the fistulous connection between the rectum and the urethra (4) The rectum has been separated from the urethra showing the fistulous openings in the rectum and the urethra

cous membrane of the urethra is turned in by three interrupted catgut sutures, and a drain placed over this. The subcutaneous tissue is then

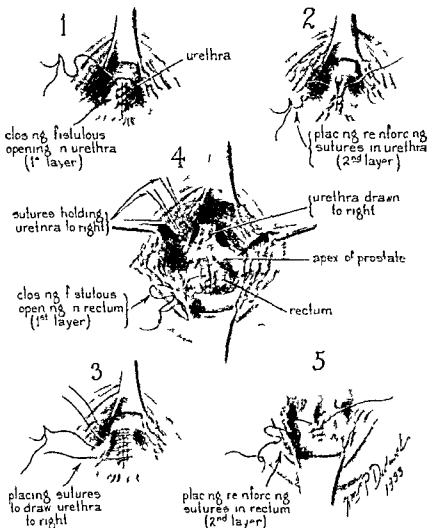
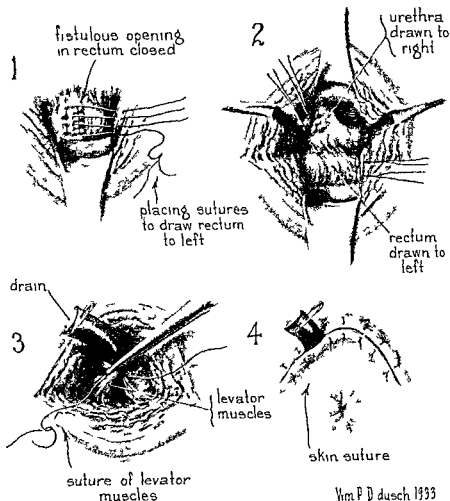


FIG. 146. Operation for recto-urethral fistula. (1, 2) The fistulous opening in the urethra is closed. (3) Sutures are inserted to draw the urethra to the right side. (4) The urethra is drawn to the right and the fistulous opening in the rectum closed.

closed with catgut and the skin with interrupted silk. The drain is removed 2 days later.

*Excision of Urethroperineal Fistula*

**Technic** The excision of a urethroperineal fistula is illustrated in figures 143 and 144



Wm P Dusch 1933

FIG 147 Operation for recto urethral fistula (1) Placing sutures to draw the rectum to the left (2) The urethra is drawn to the right and the rectum to the left so that the two incisions do not approximate (3) Repair of the perineum (4) Skin closure

The patient is prepared in the usual manner. An incision is made around the fistulous opening, which has been outlined by the injection of methylene blue. The fistulous tract is dissected down to its opening in the urethra and excised. The urethra is then closed with interrupted chromic gut or silver wire sutures, turning the mucous edges well inward.

The skin is repaired by interrupted silk sutures and a drain inserted into the repaired area and left for about 24 hours

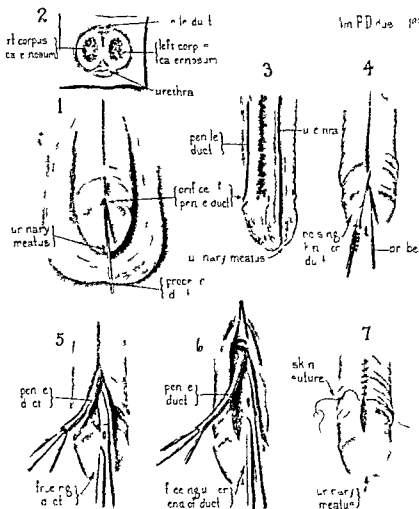


FIG 148 Excision of accessory urethral channel (1) View of penis showing a probe in the channel on the dorsum of the penis (2) Cross section showing the accessory duct the corpora cavernosa and the urethra (3) Sagittal section illustrating the extent of the accessory channel and its relation to the urethra (4) Incising the skin over the accessory duct (5) 6) Freeing and incising the duct (7) Skin suture

### *Operative Treatment of Recto Urethral Fistula*

Recto urethral fistula is one of the most difficult of surgical conditions to cure. The first step is the diversion of both the fecal and the urinary streams

**Lowsley Method of Repair** Following this Lowsley repairs both the urethral and rectal fistulas and draws the former to the right side of the

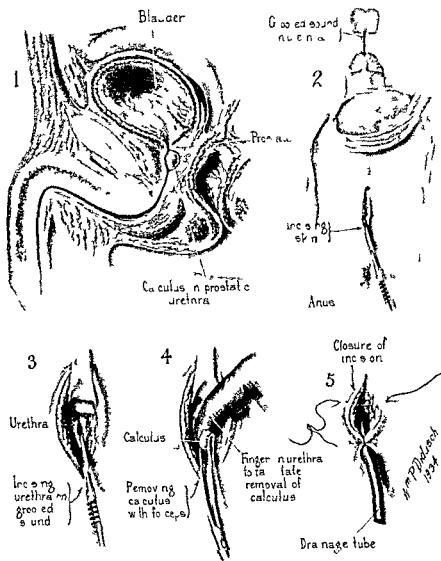


FIG. 149 Removal of a stone in the prostatic urethra through a perineal incision (1) Sagittal section showing a calculus in the prostatic urethra just external to the vesical orifice (2) With a grooved sound in the urethra a midline perineal incision is made (3) Incising the urethra at the membranous port on (4) The urethra is dilated and the stone removed with forceps (5) A drainage tube is inserted into the bladder and the wound closed

wound and the latter to the left side so that the two incisions do not approximate (Figs 145 to 147)

*Excision of Accessory Channel*

Infection in a blind ending accessory channel opening on the surface of the penis is difficult to eradicate so that it is sometimes necessary to remove such a channel in its entirety.

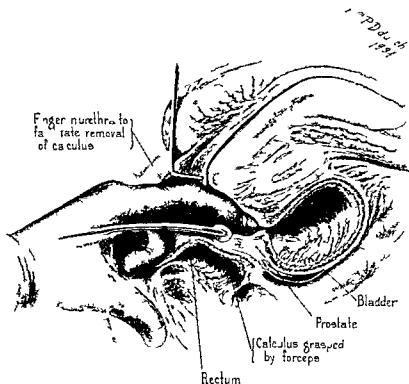


FIG. 150 Removal of a stone in the prostatic urethra through a perineal incision. Sagittal section showing the finger drawing the calculus downward and the forceps about to remove it.

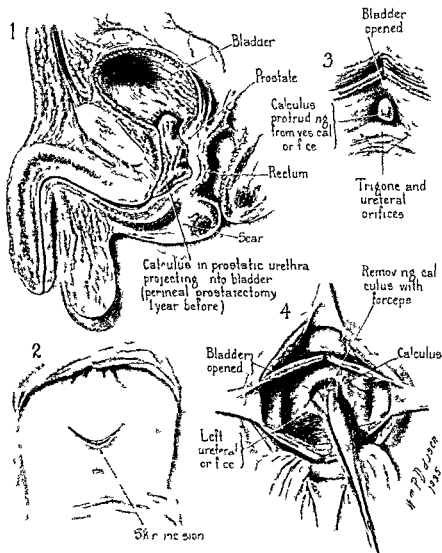
**Technic**—An incision is made over the accessory channel into which a probe has been inserted. The incision is deepened and the channel entirely isolated and excised (Fig. 148). The subcutaneous tissue is closed with plain catgut and the skin with interrupted sutures of silk.

*Operative Treatment of Urethral Calculus*

Surgery is usually necessary for the removal of large or impacted stones in the posterior urethra.



**Removal Through a Perineal Incision** Figures 149 and 150 show the removal of a stone from the posterior urethra through a perineal incision



**FIG. 151** Removal of a calculus from the prostatic urethra through a suprapubic incision (1) Sectional drawing showing a large calculus in the prostatic urethra projecting into the bladder (2) Suprapubic incision (3) The bladder has been opened suprapubically, and the tip of the stone can be seen protruding from the vesical orifice (4) Removing the stone with the forceps through the suprapubic incision

With a grooved sound in the urethra, a midline perineal incision is made into the urethra at the membranous portion. The urethra is dilated

and the stone removed with forceps. A drain is inserted into the bladder and fixed in position with a silkworm gut suture. Another suture is sometimes required to close the urethra.

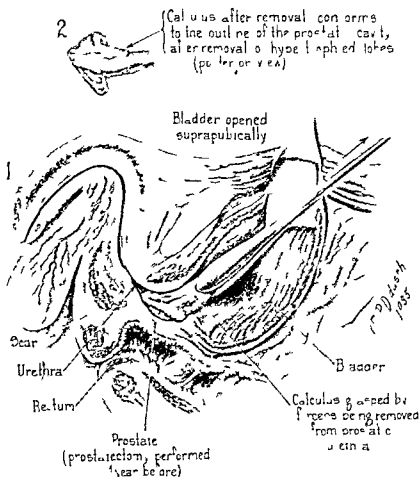


FIG. 152 Removal of a calculus from the prostatic urethra through a suprapubic incision. (1) Sagittal view showing the calculus being removed with the forceps. (2) In shape the removed calculus conforms to the outline of the prostatic cavity following removal of the hypertrophied lobes.

**Removal Through a Suprapubic Incision** In figures 151 and 152 is shown a large urethral calculus wedged firmly into the prostatic cavity remaining after the removal of the gland. This stone was removed through a suprapubic incision. The bladder is exposed by the preferred

incision and opened (Suprapubic Cystostomy, p 1105) A portion of the calculus can usually be seen protruding from the vesical orifice This is grasped with the stone forceps and by gentle manipulation removed with the forceps (Fig 152) The bladder is closed in the usual manner with a double suction tube and a drain into the supravescical space

### *Repair of Hypospadias and Epispadias*

The surgical repair of hypospadias and epispadias has already been considered under Operative Treatment of the Penis (pp 335 and 347)

### *Postoperative Considerations in Urethral Surgery*

In any intervention upon the male urethra extensive or slight the surgeon's work should be regarded as incomplete until the urethra has been dilated to a caliber of at least No 28 F and maintained at this caliber for some months This after treatment of urethral lesions sometimes requires considerable adroitness on the physician's part Even in free clinics it is a difficult matter to make out patients attend long enough to obtain a permanent cure When the patient must pay a fee for what he considers an unnecessary precaution securing his attendance becomes even harder

A person who has once suffered a break in the continuity of his urethral wall can never thereafter be wholly relieved of the threat of stricture nor can one who has had a tight urethral stricture ever regard himself as entirely free from the danger of recurrence The urethra should therefore be examined and dilated if necessary, at least once a year It is our practice regularly to suggest to such a patient that he select a day which he can easily remember—such as the day after his birthday or a holiday—and make it a point to have such an investigation annually Although this precaution is particularly important after surgery it also may well be taken when non operative methods have been used

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## CHAPTER XXII

### GONORRHEA IN THE MALE<sup>1</sup>

**Introduction** Gonorrhea is one of the oldest diseases of which we have record, and is more prevalent today than ever before. During the years immediately following World War I, the incidence of venereal diseases reached an unprecedented peak, compelling a greater recognition of their importance as vital social, public health, and medical problems. In certain countries, especially the Scandinavian nations, vigorous campaigns for their eradication have been in progress for the last two decades, with a notable reduction in the incidence of both gonorrhea and syphilis. In the United States, a nationwide movement is now on foot to place the handling of these devastating diseases upon a franker and more scientific basis. While thus far the greater effort has been expended against syphilis, gonorrhea has received some attention.

The combating of the venereal diseases has been rendered tremendously difficult in the past by a public prejudice and ignorance that have fostered silence and concealment, and have made adequate handling of the diseases as medical problems impossible. Their eradication depends on an aroused and educated public opinion, removal of the age-long attitude of prejudice, ignorance, and indifference, and a fuller realization of its responsibility on the part of the medical profession itself.

The newly awakened interest in the problem of venereal diseases has given impulse to an increased scientific activity that has already begun to pay its dividends. The old conception of gonorrhea as a more or less localized disease, self-limiting in character, with only a short period of coccal viability in the infected organs, and of no appreciable carrier chronicity, is no longer tenable in the light of properly interpreted results of research. Committees are working their way through the vast literature on gonorrhea and consulting experts all over the world in an effort to weed out all that is of only historic interest. Once this clearing has been accomplished, we shall know what is available in the way of

<sup>1</sup>This chapter has been written in collaboration with Dr. Andrew P. Peterson, former Chief of Clinic of the Department of Urology (James Buchanan Brady Foundation) of the New York Hospital and Instructor in Urology in the New York University School of Medicine.

proved facts and what must yet be ascertained. In the light of what has already been done, however, several inveterate convictions of the past will have to be revised.

**History** Of the two major venereal diseases gonorrhea has scourged mankind for the longer time. Descriptions too characteristic to be misunderstood appear in the oldest medical records we possess, such as portions of the Egyptian Papyri, the ancient Japanese writings, and the Old Testament of the Hebrews. Hippocrates described an affection that was undoubtedly gonorrhea, and similar references appear in the works of Alexander of Tralles, written in the sixth century. Modern conceptions of the disease, however, date only from the year 1719, when Morgagni produced a classic work upon the complications of gonorrhea.

At the time it first appeared in Europe syphilis, because of its systemic manifestations, was recognized as a disease differing from other venereal diseases. Nevertheless, for many years gonorrhea and syphilis were regarded as two different manifestations of the same disease—a misconception engendered probably by the fact that both diseases were known to be contracted and propagated by sexual intercourse. This belief, which was subscribed to by many celebrated physicians of the sixteenth, seventeenth and eighteenth centuries (notably John Hunter) held sway until 1838 when Ricord demonstrated the difference between gonorrhea and syphilis. But despite his extensive investigations and really thorough apprehension of the nature of gonorrhea Ricord stoutly maintained that it was not infectious, being simply a catarrh of the urethral mucous membrane due to the introduction of irritants which might be of many different origins. Other workers, however, soon demonstrated beyond a doubt that inoculation of the urethra with gonorrheal pus was regularly followed by a characteristic urethritis.

Forty years passed before Neisser, following the bacteriological methods instituted by Weigert and Robert Koch, was able to isolate the specific organism. In 1879 he showed by staining the invariable presence of a characteristic diplococcus in the urethral secretions. Three years later Neisser demonstrated the morphological characteristics of the organism which now bears his name, as well as its mode of division and its ordinary appearance within the pus cell. In 1885 Bumm succeeded in growing pure cultures of the gonococcus, and by inoculation of the human urethra with the organism thus obtained produced the full proof of its etiological importance in the production of gonorrhea.

**Public Health and Epidemiological Aspects** The public health aspect of gonorrhea presents two exceedingly difficult problems (1) the cure of the diseased, (2) the protection of those not yet infected. In the days of "approved" prostitution sources of infection were readily located and checked, but since the abolishment of this practice, track cannot be kept of persons who are serving as the chief sources of dissemination. As the actual protection of the uninfected is, for sociological reasons, a difficult if not unsolvable problem, control through the education of both sexes, especially those between the ages of 15 and 18 years, remains the only feasible hope.

Prophylaxis, consisting of the use of bactericidal solutions or salves, is likely to be of value only where direct and thorough supervision and some degree of coercion can be exercised—for instance, in armies and navies. In civilian life, the education necessary for the intelligent use of these measures is, as a rule, lacking, and even where it is present, the widespread use of alcohol will defeat prophylactic possibilities in many cases. Only the untiring education of all the laity, with the help of well-edited lectures and motion pictures, will serve to instil a "healthy fear" of gonorrhea in those who have not as yet felt its sting.

Unfortunately, measures that have proved so efficacious in the Scandinavian countries can not be applied with hope of equal success in the United States, since the most important feature of a control of delinquents—namely, a compulsory general registration with the police—is not available. Without this facility, the apprehension of absentee patients or suspected carriers is apt to present insurmountable obstacles—at least in large cities, where the need is the greatest. Since only a part of the infected seek proper treatment, and fewer still persist to final cure, no appreciable improvement in present conditions can be expected until all are compelled to undergo treatment until they are rendered non-infectious. On the other hand, there is little point in contacting the many unattended cases if, and as long as, those under medical care do not receive the full benefit of thorough treatment and an unchallengeable cure. At this date, in clinics maintained in some of our richest cities, the treatment of gonorrhea is still done in a superficial manner by untrained subalterns, the attending physician merely prescribing the procedure to be followed. The criteria of cure, required by many municipal and state institutions and private practitioners, do not as a rule go beyond from one to three negative smears and other meaningless provocative measures that are grievously inadequate.

Before the education of the lay public can be expected to effect improvement, there is need of a radical change in the attitude, and improvement in the training, of the medical profession itself. Men with a genuine interest in venereology must be trained to take the places of disinterested medical attendants, in order to safeguard and obtain cure in the lowliest of patients whose uncured gonorrhea can easily find its way into the most respectable of families. But even such ideal practice of venereology will not be able to produce satisfactory results unless it has the wholehearted cooperation of an equally adequate public health service, to assist it in its relation to the public.

Prior to the advent of the railroad and automobile, gonorrhea had the characteristics of an endemic disease, even though wars and the Crusades, assisted by a lack of understanding of the true nature of the disease, had contributed to its dissemination. Modern means of locomotion, as well as the fact that gonorrhea is closely connected with the vital function of mating, have helped to make this the most common and wide spread of all diseases.

Gonorrhea, as a disease, is not usually a killer. It does not visibly mutilate or maim, nor does it, in many instances, cause undue suffering. Its venereal nature attaches a certain stigma to the patient, inducing him to secrecy, which in itself is one of the contributory factors to its dissemination. It is of prime prophylactic importance that those who have acquired gonorrhea be taught that cure can be obtained only by proper and thorough treatment and ascertained only after a suitable period of observation. The unfortunate victims who have acquired the disease through no fault of their own (unless ignorance be deemed a fault) must not be made to feel like lepers, inducing them, in many instances, to forego medical aid. On the other hand those who are fortunate enough to have been spared should be made to realize that being infected with gonorrhea is not necessarily a reflection on one's morals, and that social or professional prestige does not confer immunity against a disease that *per se* does not impart immunity.

Gonorrhea is curable, but it takes months of thorough treatment, followed by many more months of careful checking, before a final cure can be pronounced. The reason for this lies in the asymptomatic nature of chronic gonorrhea. The, at times, minimal clinical signs and symptoms lull the carriers, and in many instances even their physicians, into a false sense of security, while the infectiousness remains unlimited. The gonococcus has a way of nesting deep in the glands of the urethra, pros-



tate, and seminal vesicles, where it may for years defy efforts at discovery and eradication. Single negative bacteriological findings, even cultures, possess little significance (Amann).

Accordingly, the solution of the problem will be found in preaching extreme caution to those not yet infected and in compulsory and thorough medical consultation before marriage. The patients themselves must be educated to the fact that chronic gonorrhea is difficult to cure, and that it is even more difficult to say when a cure has been effected. Stress must be laid on the fact that asymptomatic patients are the chief source of nearly all acute infections, and that only by the strictest adherence to instructions can cure be obtained and others safeguarded.

**Definition** Gonorrhea (Neisserian infection, specific urethritis, clap) is a contagious inflammation of mucous membranes caused by the gonococcus of Neisser. It affects primarily the mucous membrane of the urinary and genital tracts in both the male and female, also the rectum and the conjunctiva, particularly that of infants. Dissemination of the organisms through the blood stream causes complications, such as arthritis, iritis, endocarditis, and septicemia.

**Bacteriology** The gonococcus is a non motile vegetable parasite of a coffee bean shape, occurring in pairs, with the concave sides apposing. The individual coccus measures, on the average, 1.6 by 0.8 microns. It stains readily with slightly alkaline dyes (for example, methylene blue) and decolorizes by the Gram method—that is, it is gram negative. Deviations from this classic form and these staining qualities—such as mucoid forms with a definite capsule formation, occurring in both monococcal and diplococcal units of greatly varying sizes—are common. Most of these are found in apparently cured cases, where their presence is seldom connected with gonorrhea.

In smears taken from acute cases, the gonococcus appears chiefly within polymorphonuclear leukocytes and shows typical morphological characteristics. In chronic cases, the extracellular location is more prevalent, and variations in size, shape, and intensity of staining can be observed. These variations may make the identification of the gonococcus in smears difficult or impossible.

While in the average case a satisfactory diagnosis can be made on the basis of one positive smear and a history of exposure to infection, in atypical cases and for forensic purposes a cultural identification of the infecting organism is essential.

The gonococcus grows on culture media containing some human or

animal protein (such as ascitic fluid, whole blood, or defibrinated blood) at optimal temperatures of from 37 to 37.5°C and pH values of from 7.2 to 7.7, preferably under reduced oxygen or partial CO<sub>2</sub> atmosphere. The colonies are of a peculiar mother-of-pearl color, and vary in size, shape, and appearance according to the composition of the nutritive medium and the age of the culture. Cultures over 72 hours old show a bacteriolysis beginning in the center of the colonies. Smears taken from such colonies show so called involution forms, in which the typical morphological characteristics are lost. Upon transfer of the organisms onto a fresh medium, the viability and typical morphological characteristics return. The cultures are sensitive to changes of temperature and moisture content and pH of the medium to an extent that improper handling and carelessly prepared media greatly influence the reliability of cultural results.

In order to identify the gonococcus and differentiate it from other pathogenic or saprophytic microorganisms occurring in the urogenital tract, such as the *Micrococcus catarrhalis* and *cinereus*, *Diplococcus flauus*, pneumococcus, and meningococcus, cultures are indispensable. Identification of the gonococcus in cultures can be made by the polysaccharide test and the oxydase reaction. Of gram negative coccil organisms found in the urethra the gonococcus alone ferments dextrose (d glucose), not maltose or levulose. Gonococcus colonies flooded with a 1 per cent solution of para amino dimethylanilin monohydrochloride show an intensive purplish discoloration that is specific for the organism (McLeod Carpenter).

Apart from certain minor morphological variations to be observed in smears and cultures, gonococci obtained from different sources differ in their serological behavior and in the biochemical composition of the bacterial cell. Torrey, Jotten, Tullock, and others have utilized the protein component for the isolation of arbitrary strains or types by means of agglutination. Casper and others have attempted the isolation of types with the use of the polysaccharide component. A uniform classification of gonococcus strains or types, similar to that of the pneumococcus, has not yet been effected, even though the sera of animals inoculated with a particular type of the gonococcus unquestionably possess type specific antibodies.

Organic reaction to the polysaccharide component is manifested in the form of an allergic phenomenon which has been used for cutaneous tests for the determination of the presence or absence of gonococcal infection.

Such cutaneous reaction may be present regardless of a serological response and seems to be equally type specific. The clinical application of such cutaneous tests, however, is of little practical value.

The toxic effect of the gonococcus is due to its endotoxin, which is liberated only upon decomposition of the bacterial cell. This gonococcal antigen causes a specific antibody response in the host; the intensity of which appears to be in a direct ratio to the number of decomposing organisms and thus to the severity of the infection. This phenomenon was utilized by Bordet and Gengou for the development of the gonococcus complement fixation test, along lines analogous to that of the Wassermann reaction. The gonococcus complement fixation test is very delicate, and unless the antigen is prepared with the greatest care and contains the greatest possible number of strains or types—that is, it is polyvalent—its results are likely to be inconsistent with clinical findings. It has been extensively used in Europe, and, since McNeal's modification of the technic, is being more and more relied upon for the diagnosis or exclusion of gonorrhea.

Both the gonococcus complement fixation test, as a demonstration of an antibody response to a specific bacterial antigen, and the allergic reaction to a type specific polysaccharide, are to be taken into consideration only when positive or reverting. Consistently negative results may mean the absence of a specific infection, or of a type specific antigen, or antibody response.

The gonococcus complement fixation test turns positive from 3 to 6 weeks following an infection of average virulence and remains so for from 6 to 12 weeks or longer after a cure has been obtained, especially if vaccines or filtrates have been administered. A gradual diminution in the intensity of the positive reaction can be observed simultaneously with progressive clinical improvement. Persistently positive complement fixation tests in the presence of a sero positive syphilis can not be regarded as indicative of gonorrhea. In such cases reliance can be placed only upon smears and cultures.

*Immunology.* There is no such thing as a natural immunity against the gonococcus, and but little is to be demonstrated of any acquired immunity. Apparent organic or localized tissue resistance is, in all probability, more a loss of virulence of the gonococcus than any defensive power acquired by the mucosa. Any enrichment of the medium, such as that resulting from a slight bleeding after the passage of instruments or chemical irritation, will bring about a renewed virulence of the or

ganism Reinfection with the same strain, or superimposed infection with any other strain, can occur at any time or any number of times during the course of an acute or chronic gonorrhea

**Predisposing Factors** Certain congenital and acquired conditions predispose to the acquisition of gonorrhea Among them are anomalies such as first degree hypospadias and epispadias, existing local irritation, balanitis, mild balanoposthitis, and phimosis The excessive use of alcohol is an important factor, since it is when under its influence that those exposed most frequently neglect to apply preventive measures

**Modes of Transmission** The disease is propagated mainly by sexual intercourse It may also be contracted by contact with infected objects, such as instruments, towels, and soiled linens, but this in the adult male is a fairly remote possibility Ophthalmia neonatorum, acquired at birth from the infected mother, and vulvovaginitis contracted at birth or, more frequently, through contact with infected materials, make up the greater proportion of cases acquired without sexual relationship Children may contract the disease from sleeping with infected adults

**Pathology.** As Amann expresses it, of all microorganisms pathogenic to the human body the gonococcus has reached the highest degree of parasitic adaptation In contradistinction to other microorganisms, the gonococcus does not require any lesion, previous injury, or other predisposing condition, but a few viable coccal units, implanted onto the healthiest human mucosa, will produce an immediate purulent inflammation Most other organisms attack human beings and animals alike, but the gonococcus thrives only on human mucous membranes

**Acute Anterior Urethritis** Inoculation of the mucosa is the beginning of an acute gonorrhea Upon inoculation, the transplanted gonococci proliferate As the living microorganism has only slight demonstrable effect on the tissues or cells, the mucosa will not respond until the life cycle of numerous gonococci has been run and, upon decomposition of their dead bodies, endotoxin is liberated The interim between inoculation and the appearance of clinical symptoms is referred to as the *incubation period* Once this toxic liberation has reached considerable proportions, it will elicit a corresponding response from the mucosa, the clinical manifestations of which are termed *acute urethritis*

The spread of the organisms within the urethra is accomplished by surface growth, and is unchecked until the external sphincter is reached The squamous cell lining of the fossa navicularis is but little more resistant than the columnar epithelium of the anterior urethra Both

show localized destruction of the epithelium, and through these breaks in the surface serum and microscopic amounts of blood enter the urethral lumen. The concurrent intensive diapedesis of leukocytes into the superficial layer of the mucosa, and, through it, into the urethral lumen, gives a purulent character to the mucous secretion. The denuded areas of the mucous membrane, being unusually rich in nutritive medium, form points of focal growth within the generally inflamed urethra. Gonococci, coming to lie between the loosened epithelial cells, are carried into the submucosa by the capillary lymph stream, where they fall an easy prey to phagocytes. During the course of an acute gonorrhea a large number of gonococci are flushed away into the lymphatics and blood stream, and only the presence of phagocytes keeps the majority of the cases from a clinically evident bacteremia. Lautier has cultured the gonococcus from the blood of uncomplicated cases of gonorrhea. Lofaro succeeded in obtaining positive blood cultures in 39 out of 67 cases of acute and chronic gonococcal urethritis. Copelli and Gennari have shown that gonococcemia exists for a shorter or longer period of time in all cases of urethritis, even if uncomplicated. At any rate, a "penetration" of the gonococcus, presupposing active motility and invasion similar to that of the *Spirochæta pallida*, is a term inconsistent with bacteriological evidence.

The histopathological picture of an acute gonococcal urethritis is identical with that of an acute inflammatory process. Hyperemia of the mucosa, with round cell infiltration of the submucosa or even of the adventitia, is commonly seen, especially in the connective tissue surrounding infected urethral glands. The degree of engorgement is proportional to the virulence of the infection and may vary from a hardly perceptible involvement to a hemorrhagic urethritis.

In the ideal case of gonococcal urethritis the organisms spread to the external sphincter and lose their virulence before extensive pathological changes have taken place. As the gonococci gradually lose their viability and proliferate at a decreased rate, the amount of endotoxin liberated decreases. The hyperemia is reduced and damage done to the mucosa is repaired from neighboring epithelial margins. Unless a denuded area is too extensive of surface, metaplasia of the columnar epithelium into squamous is rarely observed.

Urethral glands are infected through an inflexion of the surface growth of the gonococcus into their lumina. Such infected glands become closed or temporarily obliterated by edema or accumulated debris within

their ducts to reopen upon subsidence of the hyperemia and under the pressure of the retained secretion. Scarification and fibrous plugs may close the glands permanently, causing retention cysts that may harbor viable cocci for years. Infected but draining glands may maintain recurrent urethritides by a periodical feeding of microorganisms into the urethral lumen.

*Complications of Acute Anterior Urethritis* The profuse purulent discharge may irritate the glans penis and inner layer of the prepuce giving rise to inflammatory conditions such as balanitis and balanoposthitis, commonly in conjunction with non specific pyogenic organisms.

Anomalous paraurethral ducts are always potential sources of complications. Paraurethritis and paraurethral abscess are serious complications of anterior gonococcal urethritis and frequently lead to chronicity. Strictured meatus or stenosed hypospadiac urethral orifices interfere not only with drainage but, in many cases with treatment.

Extension of the infection into a Morgagni's crypt or the urethral glands is termed *follicular urethritis*. Occlusion of their ducts leads to the formation of retention cysts which may break down and extend into the adventitia forming periurethral abscesses. Extension of a paraurethral or periurethral inflammation into the corpus cavernosum is termed *cavernitis*. This is usually accompanied by a more or less extensive lymphangitis and unilateral or bilateral inguinal lymphadenitis. Infection of Tyson's glands, which are located on both sides of the frenulum, may give rise to abscess formation, which may simulate paraurethral conditions or even a primary luetic affection.

*Acute Posterior Urethritis* Extension of the infection from the anterior urethra beyond the external sphincter is usually accomplished by continuity, in which case the posterior urethra becomes acutely inflamed, or it may occur through the lymphatics in which event the onset is gradual and may remain asymptomatic. Acute posterior urethritis is of even greater significance than anterior urethritis because of subsequent involvement of the prostate and, possibly, of the seminal vesicles which may lead to extensive destruction of their glandular elements (Prostatitis, p 806, Seminal Vesiculitis, p 535). Acute posterior urethritis involves the entire posterior urethra from the external sphincter to the bladder neck and the trigone. The acute hyperemia and edema occlude all the excretory ducts leading into the posterior urethra thereby causing enlargement of the prostate and seminal vesicles even in cases where no infection of these organs has taken place. However, an acute

prostatitis accompanies the majority of posterior urethritides, and extension of the infection into the ejaculatory ducts, and through them into the seminal vesicles, is far more common than is generally realized

*Chronic Urethritis* Whenever the infecting organisms fail to lose their virulence within from 2 to 4 weeks, or establish foci from which recurrent outpourings of infectious material prevent recovery of the mucosa chronicity is the result. Such foci exist in the form of anomalous paraurethral ducts or urethral glands. Infiltration of long standing leads to scarification of the urethral wall and the formation of various types of strictures. These interfere with good drainage of the anterior urethra, and result in a late extension of the process into the posterior urethra, prostate, and seminal vesicles. On the other hand, a posterior urethritis or prostatitis can maintain a chronic anterior urethritis by a continuous reinfection of the anterior urethra with the last few drops of voided urine, containing pus and organisms from the deep urethra and its glands.

The factors causing chronicity of a posterior urethritis are identical with those affecting the anterior urethra. A chronic posterior urethritis handicaps recovery from prostatitis and seminal vesiculitis by interfering with proper drainage. On the other hand, infectious prostatic or vesicular secretion can maintain a chronic irritation of the posterior urethra that will lead to a thickening of the mucous membrane and thus to increasing faulty drainage.

While acute anterior urethritis is usually curable, if properly treated by modern methods, occasional cases become chronic regardless of the treatment employed. Extension of the infection, and with it chronicity, is sometimes seen in spite of treatment—or because of it. External sphincters of subnormal tone, anomalous glands or ducts in the anterior urethra forming favored sites of focal infection, remnants of previous attacks in the form of strictures or extensive infiltration together with the unfavorable behavior of the patient, serve to induce and maintain chronicity.

*Complications of Acute and Chronic Urethritis* The complications that can occur at any time during the course of an anterior or posterior, acute or chronic, gonococcal infection are either local or systemic in nature.

*The local complications* most commonly observed are balanitis and balanoposthitis. Hyperacute involvement of a paraurethral duct may lead to the formation of a paraurethral abscess, and, if this is located on the dorsal surface of the urethra, involvement of the corpus cavernosum

(cavernitis) Abscess formation in the urethral glands (periurethral abscess) can occur at any stage of the disease. Prolonged anterior urethritis leads to the development of hard infiltrations and various forms of urethral strictures, especially if strong solutions of chemicals have been used. An individual or racial disposition for the development of strictures is often seen—for example, in the Negro. Strictures of the posterior urethra are not nearly so common as those of the anterior canal.

The complications of posterior urethritis—acute prostatitis, seminal vesiculitis, epididymitis, prostatic abscess, and the rare seminal vesicular abscess—have been considered elsewhere.

Involvement of the vesical neck and of the trigone is common, but generalized cystitis and extension of the infection through the ureters to the kidney pelvis are rare.

Inflammatory involvement of the posterior urethra is seldom, if ever, restricted to the urethra proper. Circumscribed processes on the order of a verumontanitis or even a utriculitis are usually singled-out phases of a chronic prostatitis or seminal vesiculitis, or both. Excepting the relatively rare hematogenous infection of the epididymes, a chronic epididymitis is the palpable evidence of a preexistent vesicular and prostatic infection.

*Systemic complications* of a gonococcal infection of the male urethra and its adnexa are most prevalent in the acute stage but may occur at any time, even in apparently dormant chronic cases, seemingly without provocation. The most common of these is a certain degree of general malaise, caused by a resorption of toxins and a greater or less degree of gonococcemia. Involvement of the endocardium, polyarthritis, and cutaneous eruptions occur in from 1 to 2 per cent of all cases. The joints most commonly affected are the left and right knees, ankles, feet, wrists, sterno-clavicular and temporo-mandibular joints. The seriousness of these complications depends chiefly on the virulence of the infecting organism. The local trauma frequently preceding systemic complications need not be extensive. Endocarditic complications were commonly fatal until recently, and hyperacute polyarthritis was liable to leave permanent impairment of the affected joints. Since the introduction of fever therapy and sulfanilamide, however, these complications have lost much of their hopelessness.

*Symptoms* *Acute Gonorrhea* The earliest symptom of an acute anterior urethritis is a tingling sensation in the fossa navicularis, which



gradually extends over the entire length of the urethra. This tingling becomes more intense during the following 24 to 72 hours, until it assumes burning proportions, especially on urination. The mucous secretion becomes profuse and purulent. The intensity of these symptoms is subject to great individual variations. In mild cases the discharge is light and scanty and the burning may be absent.

The external meatus is swollen and reddened. The urethra is thickened and sensitive to palpation. Peracute cases are usually accompanied by priapism. There is no frequency or urgency present at this stage.

The acuteness of the infection gradually subsides in 3 to 6 weeks, and the clinical symptoms decline in intensity.

Extension of the infection into the posterior urethra is accompanied by dysuria, frequency, urgency, and marked perineal discomfort. Terminal hematuria, during the course of an acute gonorrhea, is a sign of acute posterior urethritis.

Acute inflammation of the prostate presents symptoms identical with those of an acute posterior urethritis, with a palpable enlargement of the gland and a transitory retention of urine, caused by compression of the posterior urethra. This retention may be complete and may necessitate surgical intervention either in the form of catheterization or, in the case of prostatic abscess, prostatotomy.

The symptoms of an acute seminal vesiculitis are often overshadowed by the coexistent prostatitis and epididymitis. In rare cases, where the inflammation is restricted to one of the vesicles, a feeling of fulness and pain in the suprapubic region and the corresponding inguinal region and hip are the most common clinical signs. An enlarged, infiltrated, and very tender vesicle is the most reliable objective symptom of an acute vesiculitis.

Paraurethral abscesses show a more diffuse infiltration and swelling of the penis than do those of the periurethral glands, but the acute inflammatory nature of both complications will be evident upon inspection and palpation. In acute cowperitis, Cowper's glands, which normally are palpated only with difficulty, can easily be located alongside the bulbous urethra. A palpable enlargement of these glands, felt with the index finger in the rectum and the thumb on the perineum, is of differential diagnostic significance. Abscesses of Cowper's glands are distinctly separated from the urethra while periurethral abscesses are closely attached to it.

*Chronic Gonorrhea* It is difficult to differentiate between the symp

tomatology of chronic anterior and chronic posterior urethritis, chiefly because an existing posterior urethritis invariably affects the anterior urethra. The presence of purulent or mucopurulent shreds in the urine is indicative of chronic urethritis. Should these occur in both the first and last few ounces of voided urine, an involvement of the entire urethra can be presumed. It seems advisable to mention here certain limitations of the two, three, and five glass tests. Unless the first glass contains at least 150 cc of urine, shreds belonging in the first glass will be found in the second or last glass, creating a false impression as to the location of the lesion. Moreover, shreds originating in the posterior urethra are washed away by the first few ounces of urine together with those from the anterior canal. Only the characteristic small, round globules found in the last few cubic centimeters of voided urine can be taken as indicative of a posterior urethritis. A grayish or white discharge can be observed only after prolonged retention of the urine over a period of 6 to 8 hours—for example, upon arising. Excesses in alcohol and sexual stimulus not only increase the amount of the discharge but its purulent content as well.

Chronic posterior urethritis shares the symptoms of the chronic prostatitis that almost always accompanies it. Shreds, globules, and commata in the last 2 ounces of voided urine, or, in their absence, an increased white cell count in the sediment of the last portion voided, point to an involvement of the posterior urethra. Other clinical signs of posterior urethral and adnexal processes are referred pain in the glans penis, urgency and frequency of urination, a feeling of pressure in the perineum and rectum, and pain in the sacral, perineal, gluteal, coccyx, or inguinal regions. Various types of paresthesia along the distribution of the ilioinguinal, genitofemoral, pudic, and sciatic nerves are commonly associated with chronic inflammatory conditions of the posterior urethra and its glands.

The objective symptoms are infiltration of the prostate, seminal vesicles, and epididymes, with a symmetric or asymmetric enlargement of one or all.

*Systemic Symptoms* The systemic symptoms of acute gonococcal urethritis may be so slight as to be overlooked. Occasionally some degree of general malaise is reported by the patient, usually in a direct ratio to the severity of the local process. The acquisition of gonorrhea is a shocking experience for the patient, to which the more sensitive and inexperienced respond with a nervous depression. During this depres-

sive state, local and general manifestations of the disease are likely to be magnified until they assume alarming proportions. It is the surgeon's problem properly to discount this personal nervous element. Frequent inspection and palpation will supply the necessary information more reliably than inquiries about the patient's well being.

Extension of the infection into the posterior urethra and adnexa is nearly always accompanied by an acute toxicosis with chills and fever. Swelling of one or more joints during the course of an acute or chronic urethritis should raise the question of a possible gonococcal etiology, even if the common clinical signs of an active gonorrhea appear to be absent. Gonococcal septicemia presents the clinical picture of a septicemia, and may or may not be associated with an acute endocarditis.

The incidence of grave systemic complications is low, and ranges, according to various observers from 0.15 to 2 per cent of the cases. There is little doubt, however, that a large number of them are never diagnosed and identified with gonorrhea.

**Diagnosis** The diagnosis of gonorrhea is made upon the demonstration of the gonococcus in the urethral discharge, urine sediment, prostatic or seminal vesicular secretion, contents of abscesses or joints or in the blood. The presence of typical Gram negative extracellular and intracellular diplococcal units is, as a rule, sufficient to establish a positive diagnosis even if a corroborative history of exposure cannot be obtained. The demonstration of specific organisms is not difficult in acute cases, in which large numbers of them are present. As the disease advances, however, the gonococci become less numerous, and, with the admixture of secondary organisms it may be difficult to identify the true causative agent in smears. Under such conditions cultures are invaluable, especially if forensic purposes are to be considered.

An important factor in making a diagnosis is a proper evaluation of the past history, including previous attacks and complications and the type and extent of treatment received.

Physical examination, preliminary to diagnosis, should include inspection and palpation of the external genitalia, external meatus fully retracted prepuce, penile urethra, and the scrotal contents. The presence of congenital anomalies should be noted because of their importance in the development of complications. A careful palpation of the prostate and seminal vesicles should never be omitted. The presence of a discharge at the external meatus is noted, and smears taken and examined. The patient is then instructed to urinate in preferably, two

glasses, with 150 cc in the first glass Cloudy, hazy, or clear urine in the first and last glasses of voided specimen, with or without shreds globules, or commata, serves as an indicator of the extent of the infectious process Should the urethral discharge fail to disclose typical micro organisms, sediments of the first and last glasses are stained and examined For a reliable identification of atypical organisms of similar appearance, cultures are necessary Should a thorough search for the gonococcus fail to reveal a specific infection, repeated examinations of the prostatic and seminal vesicular secretions for pus and bacterial content are carried out on at least 2 occasions A simple palpation of these organs is not sufficient to exclude a low grade specific or non specific infection any more than an occasional sample of non purulent prostatic secretion is indicative of a healthy prostate if it shows considerable debris In such cases the second or third specimen often contains innumerable pus cells

To complete the diagnosis of a chronic gonorrhea, the passage of a bougie or sound is advisable in order to establish the presence of possible strictures

In a large number of chronic cases the most complete and thorough examination may fail to disclose the gonorrhoeic nature of the affection In these instances recourse is taken to the gonococcus complement fixation test

*The gonococcus complement fixation test* is a valuable, if not an infallible aid in determining the presence of chronic gonorrhea A single negative complement fixation test early in the course of an acute gonorrhea is of no significance, as it takes, on the average, from 3 to 6 weeks before the test turns positive A positive test during the first week of an acute urethritis is indicative of the presence of an active focus retained from a previous attack

Even though the gonococcus complement fixation test has been greatly improved and standardized, a single positive report is not to be considered specific unless it is corroborated by the clinical picture Reversion of a positive test to doubtful and negative during the course of treatment is equivalent to clinical improvement and cure, especially if performed in the same laboratory and with the same antigen A sero positive syphilis renders the complement fixation useless for the diagnosis or exclusion of gonorrhea, since a large percentage of these cases furnish false positives

*Differential Diagnosis* Of importance in making a differential diag

nosis is the chemical urethritis caused by the use of intraurethral prophylactic injections of calomel ointment and glycerine, contained in many preparations commercially available, especially if these are used in the presence of strongly alkaline urine. In early cases of this type, the pus will be found sterile by both smears and cultures until a secondary infection of the damaged urethra takes place.

Non specific urethritis is much more common than is generally suspected (Non Specific Urethritis, p. 643). It may be caused by uncleanness, or by the manipulation of the genitals with soiled hands, or by perverted sexual practices. A transitory form of non specific urethritis exists during severe inflammatory involvement of the upper respiratory tract, teeth, or ears, or in acute infectious diseases, but as a rule it is of little urological consequence. In all forms of non specific urethritis organisms are present and easily identified in smears or cultures. Existing upper urinary tract infection may make the diagnosis of an acute or chronic gonorrhea difficult or impossible. Similarly, a non gonococcal cystitis, present prior to the acquisition of gonorrhea, may overshadow both an anterior and posterior urethritis, especially if accompanied by tenesmus and terminal hematuria. Sufferers from chronic pyelonephritis occasionally contract gonorrhea and develop a urethral discharge that may easily be considered non specific. It is advisable, therefore, to look upon any profuse purulent urethral flow as potentially gonorrheal, and postpone cystoscopy until specificity has been excluded.

**Treatment.** The treatment of a gonococcal infection, simple or complicated, may be classified as *symptomatic* and *curative*. From the viewpoint of the method of administration, it can be further differentiated into *local*, *general*, *oral*, and *parenteral*.

Before the introduction of sulfanilamide and its related compounds, local measures were mainly relied upon for obtaining cures of gonorrhea. Symptomatic treatment and oral medication were employed when the condition of the patient prohibited active instrumentation, namely, during the acute stage in both anterior and posterior urethritis, prostatitis, seminal vesiculitis, and epididymitis. Oral medication was of little value beyond affording a certain amount of alleviation of symptoms. Of the many hundred proprietary preparations containing sandalwood and other balsamics none possessed any real degree of gonococidal efficacy.

The proved gonococidal efficacy of the sulfonamide drugs has, however, shifted the major emphasis in the curative treatment of gonorrhea

from local measures to chemotherapy orally or parenterally administered. While not specific for gonorrhea, these drugs have effected cures in such a high percentage of both acute and chronic neisserian infections that they can truly be said to have revolutionized the treatment of this disease. Local measures and fever therapy still have a very definite place in the treatment of gonorrhea, particularly chronic infections, but the prompt and proper use of sulfonamide therapy greatly lessens the need for their employment.

Regarding local treatment, there has been a marked tendency in recent years to use non irritating and non precipitating antiseptic solutions in the anterior urethra. The use of gonococcidal solutions in the form of urethral irrigations and instillations is of questionable benefit. The best that can be expected in the way of therapeutic results is a mild stimulation of the inflamed mucosa. Under no circumstances can one expect a direct bactericidal action upon the organisms embedded in the mucus or buried deep in the mucous membrane. Concentrated irritating chemicals and astringents cause damage out of all proportion to their doubtful therapeutic value. Such damage may not be readily evident, but the prolongation of the attack, the dissemination of the organisms into the adnexa, and postgonorrheal complications bear witness to its existence.

*Prophylactic Treatment* Preventive measures should be taken, preferably, within one hour after exposure, if applied later than this, they are of much less value. Such measures consist of preliminary cleansing of the genitalia with warm water and green soap, followed by the instillation into the urethra of 3 to 5 cc. of protargol 1 per cent, or argyrol 10 per cent, or rivanol dextrose, 2 per cent. The solution should be retained for from 5 to 10 minutes by compressing the external meatus.

The routine chemical prophylaxis recommended by the U. S. Army for all venereal disease consists of (1) initial thorough cleansing of the genitalia with green soap and water, (2) thorough washing of the parts with 1:1,000 mercury bichloride solution, (3) the urethral injection of 5 per cent mild protein silver, and (4) the thorough application of ointment of mild mercurous chloride to the parts. This has been found effective against gonorrhea and syphilis but less useful in chancroid. Army surgeons have also found that if this routine prophylaxis is reinforced by sulfathiazole taken orally for one day following exposure, the chances of infection are still further reduced. With such supplementary medication they believe, the time interval between exposure and the institution

of prophylaxis might be less important, and even where routine prophylaxis has been neglected, gonorrhea and chancroid might possibly be aborted

Stedman has recently published, in the U S Naval Medical Bulletin, a preliminary report on his results with the local use of microcrystalline sulfathiazole as prophylaxis against gonorrhea in the male. The method employed by him is as follows. The genitalia are first cleansed with soap and water and dried thoroughly. The patient then urinates. One and one half cc of 5 per cent microcrystalline sulfathiazole is instilled into the urethra and the meatus sealed with collodion, a penile clamp being applied for the few minutes that it takes the collodion to dry. The patient holds his urine as long as possible, which may be overnight or at least 4 to 6 hours if he refrains from liquids. Calomel ointment is applied in the usual way as a prophylaxis against syphilis. Microcrystalline preparations of sulfathiazole are easy to apply, have the property of remaining in a milk like suspension, and do not tend to cake as do ordinary powder preparations. Stedman believes that the results obtained by him in a relatively small series (2 infections in 400 men thus treated) definitely warrant further experimentation with this method.

*Oral Medication (Sulfonamide Therapy)* The latest, and up to the present by far the best available chemotherapy for gonorrhea is that provided by the sulfonamide group of drugs. Widespread use of sulfanilamide and allied compounds has established their great value in the treatment of both acute and chronic gonorrhea, in both sexes and at any age.

Clinical experience has shown that the different sulfa compounds differ widely in their efficacy and toxicity. Toxic by effects were very frequent with the original sulfanilamide, limiting its usefulness in ambulant cases and often forcing the discontinuance of its administration even in hospitalized cases. The more common effects of this drug are nausea, vertigo, headache, listlessness, and gastrointestinal disturbances, but skin eruptions, changes in the blood picture, acute hemolytic anemia, and even death from sulfanilamide poisoning have been reported.

Sulfathiazole, sulfadiazine, and, to a lesser extent, sulfapyridine and sulfacetimide have practically supplanted sulfanilamide and neoprontosil in the treatment of gonococcal infections.

Sulfathiazole is now very extensively employed, and is particularly effective in acute stages. In both acute and chronic infections it has produced a high percentage of cures in less time than when sulfanila

mide was used, and with fewer and less troublesome by-effects. The average dose is 2 gm daily in four doses (one after each meal and one at bedtime), continued over a period of from 5 to 10 days. Hospitalized patients may be given slightly larger doses. The initial response to treatment is usually rapid. In chronic cases, a second course may be necessary and can safely be started after a brief period of rest—usually a week to 10 days.

Sulfadiazine has also been found very effective in the treatment of acute and chronic gonorrhea, and is even better tolerated by many patients than sulfathiazole. Slightly larger doses—from 3 to 4 gm daily—can be given with safety and usually without unpleasant by-effects. When prescribed in moderate dosage, sulfadiazine is believed to have less tendency to form crystals in the urinary tract than sulfathiazole or sulfapyridine.

With every dose of a sulfa drug the patient should take 1 Gm of sodium bicarbonate in order to prevent the formation of crystals in the urine.

There is so much difference in individual tolerance of the various sulfonamide drugs that the possibility of harmful by-effects from any one of them—even those of demonstrated low toxicity—must always be kept in mind. A strict watch should be maintained over every gonorrhea patient—ambulant or hospitalized—to whom they are being administered.

The various sulfonamide compounds, their uses and their dangers, are considered in greater detail on p. 1162.

Supplemental instrumental treatment is advisable in most cases of chronic gonorrhea. Such supplementary treatment, consisting of a thorough dilatation of the entire urethra and massage of the prostate and seminal vesicles, may commence as early as the fifth to seventh day after the institution of the sulfonamide therapy. The fact that catheters and sounds can be passed with impunity, while smears taken at the time of such instrumentation show numerous intracellular and extracellular microorganisms, proves the uselessness of these measures for provocative purposes.

(*Penicillin*) Penicillin, a remarkable substance produced from a certain type of mold, has been found to be extremely effective in the treatment of gonococcal infections which are resistant to the sulfonamides (see Penicillin, p. 1181). It may be administered intravenously or intramuscularly, as well as locally. Properly made preparations have given no toxic reactions, even from the largest dosage. Clinical re-



sponse to treatment is rapid and negative bacterial cultures are usually obtained sometime between 17 and 48 hours after the institution of penicillin therapy. The difficulties confronting large scale production of penicillin are, however, very great, and the exceedingly small supplies at present available are being utilized chiefly in military medicine. Until the production of penicillin can be materially increased its employment in the treatment of gonorrhea, both in military and civilian practice, will probably remain limited to cases that are sulfonamide resistant.

*Local Treatment* **ACUTE ANTERIOR URETHRITIS** The necessity of local treatments in acute anterior urethritis has been materially reduced since the employment of sulfonamide therapy, but local therapy should be given for a week or 10 days after the diagnosis has been established. The instillation of small amounts of the mildest antiseptic solutions—such as rivanol dextrose, 1 5,000, acriflavine, 1 5,000, argyrol, 2.5 to 5 per cent, or protargol, 0.25 per cent should be the extent of local treatment so long as the first glass of voided urine is cloudy or hazy. One cc. of solution may be injected for the first few days, and the amount then slowly increased. Instillation should be made at least once a day, preferably by the physician, with the use of a 5 cc. graduated syringe and rubber olive. The edema and hyperemia of the anterior urethra during the acute stage of the disease greatly reduce the receptive capacity of this organ, limiting to as little as 1 cc. the amount of antiseptic solution that can be injected with impunity. As the urethral capacity increases with the subsidence of the inflammation, the amount of solution can gradually be increased but should not exceed 5 cc.

Variations in the tone of the urethral walls and marked changes in the capacity of individual urethras at different stages of the acute inflammation, make it practically impossible accurately to gauge the exact amount and pressure to be used. Therefore, while the Janet syringe, the hydrostatic pressure irrigation outfit and numerous variations of the hand syringe may not do harm in experienced hands, their therapeutic value is only a deduced one. In cases where the gonococcus does not lose its virulence during the first few weeks of the disease, no amount of irrigation or syringing will be able to make it do so. In the hands of practitioners inexperienced in their use and in the hands of almost all patients, these instruments are a fairly certain means of producing posterior urethritis with its complications and chronicity. The best and most effortless manner in which to irrigate the entire urethra is by the natural

stream of urine, which cannot be duplicated by artificial means. The greatest benefit of sulfonamide therapy is that it makes the use of the syringe optional—or obsolete—in two thirds of the cases.

A clearing of the first glass occurs, on the average, in 3 to 4 weeks during which time shreds appear in place of the liquid pus. In cases responding satisfactorily to sulfatherapy, this clearing of the first glass may take place in from 48 to 72 hours. At this stage a No. 14 F soft rubber catheter can be passed into the bladder and 200 cc. of acriflavine or rivanol dextrose injected. After withdrawal of the catheter, the patient is advised to empty his bladder into a specimen glass. Inspection of the returned solution will show a number of shreds, possibly tinged with blood, in which organisms can be demonstrated. This positive finding is of little significance, as an exacerbation of the inflammation does not as a rule, occur unless the urethra has been traumatized. The viability and virulence of the gonococcus at this stage are sufficiently low to permit instrumental stimulation of the urethra without ill effect.

Subsequently, at intervals of 2 to 3 days Nos. 16 and 18 F catheters are passed and the bladder filled with the preferred antiseptic solution providing that passage of the catheters is not followed by a clouding of the urine and return of the discharge. After two or three catheterizations the urethra is ready to receive curative treatment in the form of dilatation with sounds.

Because of the large number of glands in the anterior urethra all of which are potential foci of chronicity no case should be considered properly attended unless an instrumental dilatation of the entire urethra to its maximal capacity has been carried out. Residual infection in the glands of the anterior urethra is frequently the basis of recurrent attacks and complications such as strictures and periurethral abscesses. Urethral dilatation is best accomplished by the use of sounds particularly the stainless steel double tapered sound.

Urethral dilatation should not be restricted to the passage of any sound of arbitrary caliber, but should be carried gradually to the maximal capacity of the individual urethra. Such a procedure is sure to break up encysted glands and infiltration of the urethral wall whereas the use of undersized sounds leaves scarified glandular orifices unaffected. On the other hand, maximal dilatation with both even and odd sizes of sounds passed in an overlapping manner upon subsequent occasions will safely and surely open all closed glands and promote healing by draining their infectious contents.

After the passage of the sound, the patient is told to pass the solution previously injected through the catheter into a specimen glass. The returned fluid should be carefully inspected, being just as important for the proper understanding of the patient's condition as the first glass of urine. The presence of diffused liquid blood in the return is seen in cases of long standing anterior and posterior urethritis with granulations that bleed easily. Purulent shreds, occasionally with bloody centers originate from the glands of the anterior urethra. Plugs of a granular composition are found in the last portion of the returned fluid, together with globules of prostatic secretion expelled by a mild contraction of the gland due to the stimulus of the sound passing through the posterior urethra. With increasing sizes of sounds, the shreds and blood gradually disappear. As the caliber of the sounds approaches that of the capacity of the urethra, an occasional bloody shred of unusual size will be seen, bearing witness to the necessity of such maximal dilatation.

**ACUTE POSTERIOR URETHRITIS** Upon involvement of the posterior urethra, as evidenced by a turbid *second glass*, *frequency of urination*, and *dysuria*, all active local treatment is discontinued. Measures to alleviate pain, prevent further complications, and promote recovery consist in raising the patient's fluid intake and in the administration of sedatives (belladonna and morphine sulphate) per rectum. If sulfa therapy has not been employed, it should be instituted at this time. The early application of massive doses of morphine per rectum offers a decided advantage over hot rectal douches and sitz baths, apart from the difficulties of obtaining these measures under the sub-standard living conditions frequently found among patients in metropolitan and rural practices. The complete relaxation of all smooth muscle fibers produced by the use of morphine per rectum secures a surcease from pain, frequency, tenesmus, and discomfort, and provides good drainage at a time when prolonged irritation of the posterior urethra and retention of secretion in the prostate and seminal vesicles are apt to lead to further dissemination and complications.

For the treatment of acute prostatitis, vesiculitis, and epididymitis the reader is referred to the sections devoted to these conditions.

**CHRONIC URETHRITIS** Opinions differ widely as to when an acute urethritis becomes chronic, the various estimates ranging from 6 weeks to 6 months. For practical purposes, any persistent urethritis should be considered chronic upon the disappearance of acute manifestations—usually between the fourth and eighth weeks.

Sulfonamide therapy has greatly reduced the incidence of chronic gonorrheal infections. Faulty treatment or misbehavior on the part of the patient may have a certain contributory significance in the production of chronicity, but in a certain number of the cases chronicity cannot be controlled by any means at our disposal and is inherent in the structure of the particular male urinary tract and the malignancy of the strain of gonococcus causing the infection. Treatment of a chronic urethritis should, therefore, begin with a careful examination of the entire genito-urinary tract, the object of which is the exact localization of the infection and the discovery of the cause or causes of chronicity. Infiltration of the urethral walls, manifested by a reduction of the lumen, calls for a careful dilatation to maximal capacity in order to aid the resorption of infiltrative masses and provide good drainage of the glands involved, without which a cure of chronic gonorrhea is impossible. Residual infection that has withstood dilatation may exist in the form of a follicular urethritis, this can be eliminated by cauterization or coagulation of the glands through the urethroscope. Accompanying treatment of the prostate and seminal vesicles, consisting of prostatic and vesicular massage, will tend to clear up existing infection in these structures. Treatment should be persistent but not intensive, and should be given until the respective secretions assume a normal appearance. Following acute prostatitis and vesiculitis, the amount and consistency of the secretion do not, as a rule, ever reach entirely normal proportions, because of a serious impairment of the glandular function. All that one can hope for in these instances is to free the glands of pus within and of some of the adhesions without, realizing that a restitution of glandular tissues that have been destroyed and replaced by scar formation is impossible.

While urethral dilatation is being alternated with massage, three sessions a week are sufficient. Once the urethra has been dilated two treatments a week, or one every 5 days, will suffice, and can be continued for indefinite periods without harm. A so called "mechanical prostatitis" that could be ascribed to a prolonged massage of the gland will not be observed unless too much force is applied, causing intraglandular bleeding. It cannot be sufficiently emphasized that slight or moderate pressure, applied by the finger tip in the proper place and in the proper manner, will do more toward the elimination of adhesions and restoration of the glands to their normal state by stimulating their smooth muscle fibers to contract and thus promote drainage, than excessive force that can only cause added damage.

Chronic posterior urethritis, that is an almost invariable accompaniment of prostatitis and seminal vesiculitis, is one of the few conditions in which endoscopic treatment and endoscopic control of the improvement obtained are necessary. For inspection and treatment of the anterior urethra, "dry" endoscopy may be considered sufficient, but in the posterior urethra, a water distention instrument is preferable. The extent of treatment depends on the condition of the mucosa, and consists of topical applications of phenol glycerine of equal parts followed by a thorough rinsing, and the occasional coagulation of large polyps, preferably with very low current and in several stages. The application of concentrated chemical solutions (especially of nitrate of silver as it has been used in the posterior urethra, in from 1 to 20 or even 50 per cent solutions) is inconsistent with an understanding of the therapeutic problems. The use of such solutions only tends to increase the infiltration already present in the mucosa, closing off accessory prostatic ducts. The consequent failure to obtain secretion upon massage of the prostate or the seminal vesicles is due more to a lack of drainage than any appreciable clearing of pus from their secretions.

*General Therapeutic Measures* General cleanliness, careful personal hygiene, and regulation of the diet and intestinal function are important factors in the management of gonorrhea, especially during its acute stage. The patients should be instructed to secure sufficient sleep at night and as much rest during the day as their circumstances may permit. For the relief of constipation frequent but small doses of laxatives are preferable to the occasional purge. All forms of violent exercise, brisk walking, and dancing should be avoided. Sexual excitement in all its forms, whether direct or indirect, is detrimental to recovery.

Systemic treatment, especially in cases of malnutrition consists in the use of roborants such as high caloric diet, intravenous injections of iron and arsenic (where sulfanilamide is not used), and a free supply of vitamins in order to raise the patient's bodily resistance.

The administration of various vaccines and filtrates is a more direct form of systemic treatment, the aim of which is to cause the body to develop its own antibodies in response to parenterally introduced specific antigens. This form of therapy has for many years enjoyed a popularity out of all proportion to its proved value. It is questionable if its therapeutic worth exceeds that of any non specific parenterally administered protein. At any rate, it does not seem consistent with immunological evidence to expect the development of any degree of immunity, or even

increased resistance, through the use of vaccines or filtrates when the living organisms in the body are unable to impart immunity.

In recent years a form of systemic treatment has been introduced which utilizes a peculiar sensitivity of the gonococcus to febrile temperatures. Such treatment of gonorrhea, by artificially produced fever in hot air chambers or electrically heated cabinets, can be considered a definite step toward the successful management of serious complications. The drawbacks of the procedure—its limited applicability and high cost of initial investment and maintenance—render it unfit for routine use. Fever therapy should be given only in the hospital and under the continuous supervision of a thoroughly trained personnel. Before instituting this method of treatment, it is important to ascertain the thermal death time of the particular strain of gonococcus infecting the patient. Hyperpyrexia, properly used, need not be considered unduly risky. Its indiscriminate application, however, is fraught with danger. A thorough medical examination before treatment, and a constant control of the temperature and pulse during sessions, are essential for the safety of the patient. The duration of treatments, as given by various investigators, varies from several short sessions of from 5 to 6 hours each to one continuous session of 24 hours or more. Carpenter and Warren determine the duration of a single curative session by previously ascertaining the thermal death time of the particular strain of gonococcus causing the infection, when subjected to maximum tolerable febrile temperatures in water baths. Others prefer multiple short treatments, at intervals of 5 to 7 days, until the desired cure has been obtained.

While hyperpyrexia is of decided benefit in the treatment of serious complications, its routine use is impractical. A number of gonococcus strains are unusually resistant to fever, therefore, a combination of sulfonamide and fever therapy has been resorted to, with reportedly very good results, in strains that were singularly unresponsive to both forms of therapy when applied separately. Sulfonamide medication should precede fever therapy and be discontinued 3 to 7 days before fever sessions are commenced.

**Criteria of Cure** The cure of a gonococcal infection is termed "clinical" when all manifestations of the disease have ceased to exist but the possible presence of the gonococcus has not been excluded. It is termed "bacteriological" when the formerly infected organs are proved to be free of specific microorganisms. Such bacteriological cure may not bring with it the absence of clinical symptoms, since secondary organisms, or

chemical or mechanical irritation, may account for the persistence of clinical manifestations even when the gonococcus, after thorough and prolonged search, can not be demonstrated. In the attempt at a cure one's aim should always be the bacteriological cure, which, in terms applied to the patient, means non infectiousness.

*The differentiation between a clinical and a bacteriological cure may be difficult, and is dependent on the results of specific tests made during a suitably long period of observation.*

In determining a cure, it is not the fulfilment of all criteria on any one occasion that is most important, but, rather, that these criteria remain fulfilled after cessation of treatment and the return of the patient to an unrestricted mode of life, over a period of observation of 3 to 6 months or more, during which at least monthly examinations are made. The only restriction placed on the patient during this observation period is the proper use of a prophylactic, in which he should be instructed.

*The criteria by which cure can be ascertained are three fold in nature clinical, bacteriological and serological.*

(1) Urethral smears should be negative for pus and specific organisms.

(2) The centrifuged sediment of the first 150 cc. of voided urine should be negative for pus and specific organisms by smear and culture following the passage of the largest sound that the urethra will take.

(3) The centrifuged sediment of the last 60 cc. of voided urine should show similar negative results.

(4) Copious specimens of the prostatic and seminal vesicular secretion should be negative for pus and specific organisms in smears and cultures.

(5) Reversion of the gonococcus complement fixation test from positive to negative is a reliable serological indication of a cure if the successive tests have been performed in the same laboratory and with the same antigen.

Forced alcoholic provocation, especially with beer, is advisable 48 and 24 hours before check up examinations, and after the passage of maximal capacity sounds.

In cases treated by a sulfonamide, smears are of more importance than cultures since, due to a lowered vitality of the gonococcus, cultures may give negative results, while smears may show intracellular and extracellular organisms.

The difficulties encountered in practice, and the recurrences observed in supposedly cured patients, are not due to inadequacy of the criteria of cure, but, rather, to lax application of such criteria.

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## CHAPTER XXIII

### COWPER'S GLANDS

Behind the urethral bulb lie two (sometimes three) small mucous glands which were first described in detail by William Cowper the English anatomist, in 1699, hence the name by which they are popularly known—*Cowper's glands*. The bulbo urethral glands were originally pointed out to anatomists however, by Mery, of Paris, in 1684. Important later writings upon the subject are the Paris thesis of Gubler (1849), Englisch's classic researches upon the urethra and its associated glands (1870-1891), and the monograph of Paul Lebreton (1904). Lebreton reviewed all previous work, and his monograph is still regarded as the chief source of information on the bulbo urethral glands.

#### A. EMBRYOLOGY OF COWPER'S GLANDS

*Origin and Development.* The embryology of Cowper's glands has been carefully studied by Hogge (1904), von Lichtenberg (1906), Eggerth (1915) and Hertwig (1920).

Cowper's glands arise from two symmetrical diverticula originating in the pelvic segment of the urogenital sinus at an early stage of embryonic life. In sections made from embryos in the beginning of the third month of fetal development Hogge observed little swellings in the lining of the urogenital sinus which appeared to be forerunners of the first glandular buds but it was not until the fetus had attained a length of approximately 120 mm (4 months) that the bulbo-urethral glands actually appeared in the form of small lateral buddings directed toward the rudiment of the urethral bulb. In embryos of only 30 mm length Eggerth was able to observe the anlagen of Cowper's glands as solid epithelial buds arising from the median lateral fold on the wall of the urogenital sinus. He found evidence of branching at 50 to 60 mm, and noted that the development of the glands on the two sides is not symmetrical.

These epithelial buds are from the first embedded in the firm mesodermal tissue which forms the corpus cavernosum urethrae and extend in a direction almost parallel to the seminal canal until they reach the less compact mesodermal tissue lying between the seminal canal and the rectum. As they are at first much constricted by their growth through

relatively unyielding tissue, but are able to expand as they approach the rectal wall, each gland shows an intrabulbar portion with only a few short and ill developed side branches, and an extrabulbar portion well equipped with much larger branches. The side branches appear immediately after the original epithelial buds, and lumina develop in the main stem and primary branches when the embryo is 65 mm. At 120 mm the epithelium becomes glandular.

Cowper's glands attain their distinctive structure at or shortly before term, certain of their histological characteristics even indicating that for some time before birth they have been elaborating their peculiar secretion. Although in the infant these glands continue to increase in size, their development is slow when compared with that of the surrounding structures, being especially disproportionate to the growth of the branches of the ischiopubis. In their relation to adjacent structures Cowper's glands are therefore of greater importance in the fetus and the newborn than in the fully developed adult.

**Number and Classification.** Mery's original account describes only two glands lying behind the urethral bulb, but Cowper told of a third which he located in the median line at the intersection of the bulb and the membranous urethra. Later investigators confirmed Cowper's finding of a third gland but considered its occurrence as sufficiently irregular to warrant its being regarded as anomalous rather than normal. Gubler found that accessory glands are frequently present in the deep spongy tissue and on either side of the excretory ducts of the true Cowper's glands, but Lebreton, after a large number of dissections, concluded that the existence of only two definite glands can regularly be established.

Hogge made a vast number of sections of fetuses at or near term, and in recording the results of his investigations classified the bulbo urethral glands as of two distinct types: (1) two larger and higher lying *diaphragmatic glands*, so called because they are within the urogenital diaphragm, (2) the smaller accessory *bulbar glands*, made up of lobules lying deep in the spongy tissue of the bulb.

Embryologically, diaphragmatic and bulbar glands have a common origin, for they arise by an out budding of the urogenital tissue which has its origin at the bottom of the spongy urethra. Histologically, they are identical and all their excretory products find an outlet in the two ducts which open upon the lower wall of the spongy urethra. The bulbar lobules, however, are more disseminated and not as completely united as those of the diaphragmatic glands.

The diaphragmatic glands of Hogge correspond to what are commonly

referred to as *Couper's glands*. His bulbar glands are the *accessory glandules* observed by Jarjavay, Gubler, and others, who, however, regard them as inconstant and anomalous whereas Hogge considers them a normal finding and of great pathological importance.

### B ANATOMY OF COWPER'S GLANDS

**Size and Position** The bulbo urethral glands are small round, mucous glands, usually two in number, forming part of the genital system in the male. They are the homologues of Bartholin's glands in the female. They are slightly lobulated bodies of a reddish color, situated one on each side of the median line of the urethra between the prostate and the urethral bulb. The glands are embedded in the floor of the urethra between the laminae of the deep perineal fascia, in the angle formed on each side by the membranous urethra and the bulb and open upon the floor of the bulbous urethra on each side of the median line through long excretory channels.

Their upper surfaces thus lie directly beneath the deep layers of the perineal aponeurosis, separated in front by the terminal portion of the bulbar artery. The lower surfaces of the glands are in direct contact with the muscle plane forming the floor of the urethra, arising from the sphincter urethrae membranaceae. They lie parallel to the inferior lateral wall of the urethra, although more or less separated from it.

The distance between the internal borders of the two glands varies as much as 1.5 cm. in different persons, and in some dissections the two inner edges have been found united by a tiny bridge of glandular tissue.

Anatomists differ regarding the size of the glands, which has been variously described as ranging from that of a small pea to that of a hazelnut. Frequently one gland is reported as being larger than its fellow, and reports are not uncommon of both glands being on one side of the median line, or one on one side and two on the other. Lebreton found the left gland present in every dissection but in a number of his subjects the right was missing, and when both were present the left was always the larger. He therefore concluded that the well-established observation that cowperitis is left sided in the great majority of cases can be explained on purely anatomical grounds.

**Structure** Each gland is made up of grape-like clusters of lobules the walls of which are formed by a single row of pyramidal cells. The various lobules, as well as those composing the more or less inconstant accessory glands, are provided with excretory channels that pour their

accumulated secretions into a relatively long common excretory duct (3 to 4 cm long and 1.5 mm in diameter) which traverses the spongy tissue beneath the mucosa for a considerable distance before opening on the floor of the bulbous urethra through two small slit like orifices. Its course is somewhat sinuous, and all observers agree in describing a dilatation of the canal at its point of emergence from the gland. The canals are lined with basal cell epithelium, the cells being usually disposed in a single layer. In the main excretory channel the epithelium in the region of the urethra appears stratified.

The lobules are encased and held together by a stroma of connective tissue containing smooth, stratified, and elastic muscle fibers. The elastic fibers anastomose with striated fibers of the external sphincter, and this contractile mechanism compresses the lobules and ducts and empties them of their secretions.

Hogge has minutely described the excretory system, which he separates into two divisions: that of the diaphragmatic (Cowper's) glands and that of the bulbar (accessory) glands—all, however, communicating with the main excretory channels which open into the urethra. The excretory canals lie upon the lower internal surface of each diaphragmatic gland, constituting its hilum, and converge before reaching the median line. They pursue an upward course across the superior surface of the bulb, behind the bulbar artery. Ordinarily, conduits from the diaphragmatic glands of Cowper, to the number of two or three, can be observed traversing that section of the spongy tissue lying between the lower surface of the urogenital diaphragm and the inferior wall of the urethra. These conduits anastomose on each side to form a larger canal, which receives the contents of the collecting tubules of the bulbar gland, traverses the space between the spongy tissues and the urethral mucosa for a relatively long distance, and finally gains entrance to the lumen of the urethra. As the bulbar lobules are often separated by a considerable thickness of spongy tissue, their excretory ducts do not anastomose as do those of the lobules composing Cowper's glands proper. Instead each tiny lobule empties its secretions directly into the common duct communicating with the urethra.

**Blood Vessels Lymphatics Nerves** The glands receive their blood supply from branches of the bulbar artery, which, before entering the bulb, crosses the superficial aspect of the gland—most frequently about one third of the way down but sometimes further forward, so that it crosses the excretory canal rather than the gland itself. In either event,

the important point for the surgeon to bear in mind is the practically constant relation between the bulbar artery and the superficial aspect of the gland

*The veins* empty into the plexus of Santorini. They run further forward and deeper than the artery, so that their relations with the gland are less intimate

*The lymphatics* drain into the hypogastric nodes

*Innervation* is from branches of the hypogastric plexus

### C. ANOMALIES OF COWPER'S GLANDS

Anomalies of Cowper's glands are of slight clinical importance. They cause little or no disturbance, and usually go unrecognized. Deviations from the normal in the number, form, and position of the glands are common.

### D. PHYSIOLOGY OF COWPER'S GLANDS

Cowper's glands form a part of the genital system of the male. They secrete a transparent viscous fluid, so rich in albumin as to give it a glary appearance. This can often be detected as a clear drop at the meatus on sexual excitement.

The particular property of the secretion appears to be the lubrication of the urethra. Provided with collectors and a contractile mechanism, and innervated by rami of the genital nerves, these glands play a by no means negligible part in the sexual act. At the time of ejaculation they undergo rhythmic contractions and expel their collected secretions into the urethra, where they combine with the secretions of the other genital glands to form the spermatic fluid.

In his studies upon testicular function, Heller (1932) found that Cowper's glands (in animals) undergo involution following castration. A large series of experiments on laboratory animals not only demonstrated this conclusively, but also showed that precocious development took place when young animals were stimulated by gonadal extracts. This, he believes, is proof that the activities of these glands are under the control of the internal secretion of the testicle.

### E. INJURIES OF COWPER'S GLANDS

Because of their protected position, Cowper's glands are little disposed to external trauma. When injury does occur, it is likely to be a part of more extensive trauma to the neighboring structures and overshadowed by the more serious lesions.



## F. DISEASES OF COWPER'S GLANDS

*Cowperitis*

Inflammation of Cowper's glands is almost always secondary to a posterior urethritis. By far the most common causative agent is the gonococcus, but other organisms, including the tubercle bacillus, may be responsible. Mixed infections are comparatively common. Cowperitis may be *acute* or *chronic*.

## ACUTE COWPERITIS

**Etiology** Acute cowperitis is almost always due to the activities of the gonococcus, but, considering the prevalence of gonorrhea, it must be regarded as a relatively rare complication. Infection may also take place through any of the numerous organisms regularly present in the urethra, but these do not ordinarily become pathogenic until resistance has been weakened by gonococcal invasion. Although infection may occur by way of the blood stream, in the great majority of cases the organisms presumably invade the bulbo urethral glands by ascension of their ducts from the urethra. That these adjacent structures are not more often involved in an acute gonorrheal urethritis is undoubtedly due to the fact that their long excretory ducts afford them a certain measure of protection against ascension.

Acute cowperitis is a relatively late complication of gonorrheal urethritis, seldom occurring earlier than the third week. It may be due to the general penetration of the infection into the deeper tissues, or it may be lighted up by trauma, violent coitus, the passage of instruments, overforceful irrigations, or too vigorous exercise.

**Symptoms and Diagnosis** Acute cowperitis manifests itself by irritation of the urethra and perineal pain, which, beginning as a mere sense of weight in the perineum, rapidly becomes intense and radiates toward the anus, scrotum, and inside of the thigh. The bulbo urethral glands, it will be recalled, lie between the folds of the triangular ligament, surrounded by the deep perineal fascia. These structures being very unyielding, the swelling of the inflamed gland produces great tension, which accounts for the intensity of the pain. Micturition may be exceedingly painful, due to contraction of the external sphincter, and, occasionally, may even be hindered by the mechanical pressure resulting from the swelling of the gland. Similarly, pressure upon the rectum may render defecation difficult and painful.

The swelling is usually left sided. Authorities all agree that bilateral involvement is very unusual, even if two fully developed glands are

present. Probably, also, in the bilateral cases one gland, usually the left, is affected before the other.

The inflammation may progress to the point of *abscess formation*. A visible mass then appears in the perineum, for, owing to the relative length of the excretory duct, pus forming in the gland is unlikely to be discharged into the urethra. The mass commonly appears just in front of the anus and gradually extends toward the base of the scrotum, so that occasionally it may be confused with a tumor arising from the testicle or its adnexa. Above, extension is limited by the perineocrural fold, but at the median line the swelling frequently extends beyond the raphe to the unaffected side. The swelling in the perineum is accompanied by redness of the perineal skin, chills, fever, and leukocytosis.

*Fistula formation* usually results from a neglected case of abscess of Cowper's glands or it may complicate chronic inflammation of long standing. The glandular secretions, prevented from the normal evacuation into the urethra by occlusion or destruction of the excretory channel, pass through the fistula.

Unless there is abscess formation, ordinary palpation will fail to disclose inflammation of these glands. Rectal examination, however, will reveal tenderness at the bulbomembranous junction, and, if there is enlargement of the glands, they will be felt as two bean shaped masses, one on each side of the urethra at this point. The less prominent lesions may be palpated more readily if an instrument is inserted into the urethra. Urethroscopy may reveal inflammation of the tiny duct orifices. Since the ducts are usually obstructed, however, the urethroscopist will rarely actually see pus coming from the orifices even in cases where the glands are known to be involved.

**Treatment.** If abscess-formation has not yet set in, it may be possible to express the contents of the gland through the urethra by massaging the inflamed gland as vigorously as the patient's condition permits. If obstruction of the ducts prevents evacuation by this means, or if evidences of abscess-formation are present perineal incision must be performed (p. 745). If a fistula is present, extirpation of the diseased gland is usually necessary.

Cowperitis due to gonorrheal or non specific infection is treated by the same measures as the urethritis to which it is secondary.

#### CHRONIC COWPERITIS

Their long excretory ducts undoubtedly protect Cowper's glands from participation in a posterior urethritis—gonococcal or non specific—in

the majority of instances, but once the glands have become involved, the very length of the canal may prevent dislodgment of the infection from the cul de sac of the gland. Although the focus of infection thus established may be the source of persistent or recurrent infection of the urethra, it may remain entirely unrecognized until it is exacerbated to the point of suppuration or until a fistula has formed. Chronic cowperitis probably occurs much more frequently than is ordinarily recognized, but in most cases it is likely to pass unnoticed because it gives few or no suggestive symptoms and is difficult to discover, being out of reach of the diagnostic and therapeutic methods ordinarily employed. However, since it undoubtedly often is responsible for the persistence or relighting of urethral lesions, the possibility of its presence should always receive serious consideration in all cases of intractable urethritis.

### *Tuberculosis of Cowper's Glands*

**Etiology** Infection of Cowper's glands by the tubercle bacillus is rare. A few cases of primary involvement have been reported, but the cowperitis is usually secondary to a tuberculous process elsewhere in the urogenital tract, being conveyed to the glands probably by infected urine. It is doubtful however if the bacilli could find entrance to a healthy excretory canal or be retained in uninjured glandular tissue long enough to gain a foothold. It is only when the resistance of the tissues has been lowered by previous inflammation that the tubercle bacilli find a suitable soil for their propagation. It is possible that infection may also be conveyed by way of the blood stream particularly in those cases where there are isolated lesions in the erectile sheath having no direct continuity with those in the mucosa. Most of the reported cases of tuberculous cowperitis have been associated with tuberculous urethritis.

**Pathology** Two forms of tuberculous cowperitis have been distinguished.

(1) Intercapsular glandular tuberculosis, the more common type, occurs in three stages (a) massive infiltration, (b) breaking down in the center, with cavity formation, and, finally, (c) caseous cystic formation. The disease may even progress to complete destruction of the gland without impairing the integrity of the capsule. The periglandular cellular tissue remains unaffected.

(2) Diffuse glandular and periglandular tuberculosis, formation of a perineal "cold" abscess having its origin in Cowper's gland below and

behind the bulb, or from the sides or rear of the bulb, and resulting in a perineal fistula

**Symptoms and Diagnosis** Tuberculous cowperitis is most likely to be found in those suffering from pulmonary or urogenital tuberculosis. The most prominent symptom is a painless chronic discharge, which will show tubercle bacilli by the usual staining methods. If there is an associated gonorrhea, or a recent history of gonorrhea, the tuberculosis may be overlooked, particularly if gonococci are found in the discharge and there is a swelling in the penneum with the characteristics of an acute cowperitis. An intractable fistula is suggestive of a tuberculous process, but fistula formation may be present in other forms of chronic or acute cowperitis and is not an invariable finding in tuberculous cowperitis. Not infrequently the tuberculous process remains walled off. In some of the reported cases it was discovered only at autopsy.

**Treatment** Complete surgical extirpation of the diseased gland (p 745) offers the best hope of cure. This should be supplemented by the non-operative measures advocated for tuberculosis in any part of the urogenital tract (*Treatment of Inoperable and Postoperative Tuberculosis of the Urogenital Tract*, p 1196). The excision of a urethro perineal fistula is described on page 693.

### *Retention Cysts of Cowper's Glands*

Retention cysts, like other affections of Cowper's glands, probably exist unrecognized in the majority of instances.

**History** The first report of a case of retention cyst of the excretory duct of Cowper's gland that we have been able to locate is that of English (1881). In 1886, Elbogen published a detailed account of the cysts which may arise in the bulbo urethral glands. He found such cysts in 23 per cent of the males upon whom he had performed autopsies, and based his conclusions upon 17 cases, all of which were observed post-mortem. His investigations led him to conclude that these cysts may be present at any time of life, since he found them in a child of 7 days and a man of 60 years. He was inclined to believe that, when found in adults, their pathological significance was not as a rule great, that they probably often existed without producing symptoms, and that it was only in exceptional cases that they caused retention of urine and drew attention to their presence. He noted, however, that when they occur in young children the effects are likely to be much more serious, in one case at least, observed by him, causing retention of urine which eventu

ated in hypertrophy of the bladder and hydronephrosis. As regards location, he observed them 7 times in the right duct, 6 times in the left, and 4 times in both the right and left ducts. They were usually oval or piniform in shape. The size varied greatly, running from 1 to 4 cm. in width and from 5 to 9 cm. in length.

The first American writer to give any attention to the subject of these retention cysts was Crouse, of Texas, who, in 1911, published 2 case reports and made an excellent review of the literature.

In 1929, Muschat reviewed the literature on cysts of Cowper's glands, but found no cases other than those of Crouse in which correct diagnosis in the living subject had been made. Muschat added one case from his own clinic.

**Etiology.** Retention cysts of Cowper's glands are probably due as a rule to chronic inflammation with sealing off of the excretory duct through which the secretions normally are discharged. A large proportion of the patients in the recorded cases had had gonorrhea. In the newborn there may be congenital occlusion of the duct orifices. Dilatation of the duct first occurs, followed later by the formation of a sac which is filled by the retained secretion.

**Pathology.** The small number of Cowper's gland cysts on record fall into two groups: (1) those growing *into* the urethra, sometimes compressing the lumen sufficiently to disturb urination or even to cause complete retention and block the passage of instruments, (2) those *outside* the urethra, growing into the pelvic space and occupying the area of the urogenital triangle. The latter type frequently descends far enough to cause a bulging of the perineal skin.

Histologically, the wall of the sac is made up of connective tissue with a lining of cylindrical epithelium.

**Symptoms and Diagnosis.** Symptoms, when present, are usually some disturbance of urination (frequency, difficulty, diminution in the size of the stream, or, rarely, complete retention) and pain and swelling in the perineum. In neglected cases, a perineal fistula may be present.

The diagnosis is made by inspection and palpation and by urethroscopy.

**Treatment.** The best treatment is surgical extirpation of the cyst. With the modern instruments now in the hands of every urologist, the recognition and extirpation of retention cysts of Cowper's glands should present little difficulty. External incision is rarely necessary unless the cyst is very large or a perineal fistula has formed. Usually the cyst can

be removed from within the urethra. An even better method is the use of one of the numerous resecting instruments now available, with which the site may immediately be cauterized, preventing hemorrhage and guarding against recurrence. After removal of the cyst, it is well to locate and dilate the excretory duct, to prevent recurrence of the obstruction below the orifice. Only in exceptional cases will persistent recurrence necessitate removal of the entire gland.

### *Carcinoma of Cowper's Glands*

**Incidence** Malignant growths of Cowper's glands are very rare. Lebreton (1903) collected 3 cases from the literature. Paquet and Herrmann (1884), Pietrzikowski (1885), and Kocher (1886). The next report appears to be that of Blanc and his co-workers (1910) but as this case did not come to operation and there was no pathological report it cannot properly be included among the authenticated cases. An additional case fully documented was reported by Di Maio in 1928. In 1935, Uhle and Archer reported a case of primary adenocarcinoma and made a careful survey of the world's literature, and in 1937 Gutierrez recorded still another case of adenocarcinoma. Thus, only 6 fully authenticated cases of malignancy of Cowper's glands have been put on record.

**Etiology** The cause of malignant neoplasms arising in Cowper's glands can only be guessed at. In one of the reported cases (Kocher) there was a history of trauma the patient having many years before fallen astride an iron bar following which he had always suffered more or less urinary disturbance. Gutierrez' patient had had gonococcal urethritis early in life followed by urethral stricture and a chronic discharge. No etiological factors are mentioned in the other cases.

**Pathology** All of the recorded growths were carcinomatous. In most of the cases the growth was infiltrating in nature and adhered firmly both to the bulbomembranous urethra and the rectal wall.

**Symptoms and Diagnosis** The cardinal symptoms are pain in the rectum and perineum and a tumor mass in the perineum with no redness of the overlying skin and unaccompanied by any of the symptoms pointing to a cowperitis or a tuberculous process. As the growth increases in size, there is marked pain on defecation so that the condition is readily confused with lesions of the rectum. In no other urogenital neoplasm is pain present so early in the course of the disease sitting and defecation especially soon becoming distressing. In most of the reported cases

interference with micturition was either lacking or did not occur until late. This is an important differential point, for malignancy of the urethra early causes marked disturbance of urinary function.

Carcinoma of Cowper's glands may develop at any age. In the 6 recorded cases the patients' ages were 65, 19, 57, 65, 32, and 70 years respectively.

The clinical diagnosis may usually be established by rectal palpation, which will reveal the presence of a hard, tender mass in the region occupied by Cowper's glands. The final diagnosis must be made on histological examination of a specimen removed at operation.

**Prognosis** The prognosis of primary carcinoma of Cowper's glands is very grave. However, with earlier diagnosis and proper surgical treatment, better results may undoubtedly be anticipated than have been obtained in the past.

**Treatment** The treatment is as complete surgical excision of the growth as is possible, followed by implantation of radon seeds and deep x ray therapy (Radiation of Cowper's Glands, p. 1743).

### *Diseases of Cowper's Glands in Children*

Cowper's glands are very rarely affected during the early years of life. Being solely genital glands, they remain largely inactive until puberty. Even in cases of gonorrhea in young male children, the glands do not appear to share in the infection. The occurrence of cysts in young children has been mentioned, and, as we have noted, may well be an etiological factor in the production of congenital hydronephrosis.

## G OPERATIVE TREATMENT OF COWPER'S GLANDS

The surgical treatment of Cowper's glands has already been touched upon in this chapter. Many of these interventions are done intra urethrally.

### *Anesthesia*

For open operation upon Cowper's glands, spinal or sacral anesthesia is satisfactory.

### *Preparation of Skin*

The patient is shaved about the perineum and external genitals. The skin of the scrotum, penis, and perineum is cleansed with tincture of

green soap and warm water and sterilized with antiseptic solution, such as tincture of merthiolate or of zephiran, 1 1,000

Wm P Didusch 1932

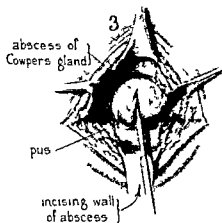
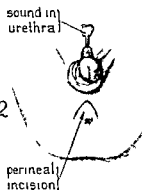
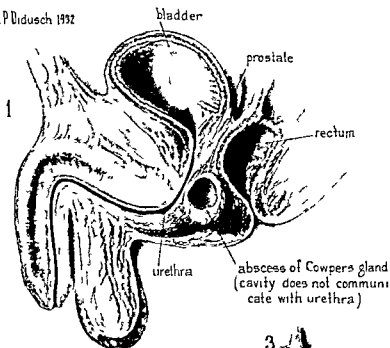


FIG 153 Incision and drainage of abscess of Cowper's gland (1) Shows an abscess of Cowper's gland having no communication with the urethra (2) Inverted V incision in the perineum (3) Incision of the wall of the abscess

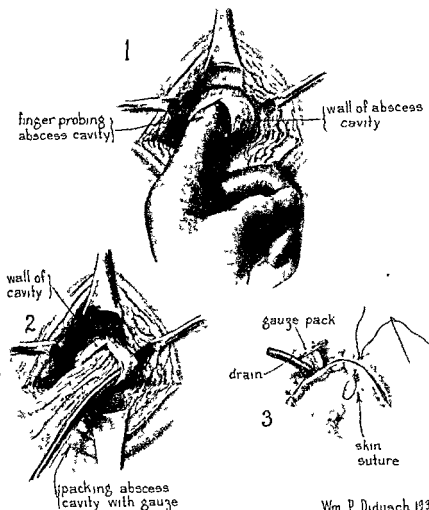
#### *Position of Patient on Operating Table*

The patient is placed on the operating table in the exaggerated lithotomy position



*Perineal Exposure of Cowper's Glands (for Incision and Drainage or for Extirpation)*

**Technic.** A hollow-backed sound is passed into the urethra, the scrotum held well out of the way, and an inverted-V incision made in



Wm P Didusch 1932

FIG. 154 Incision and drainage of abscess of Cowper's gland (1) After the pus has been evacuated from the abscess, the cavity is thoroughly probed with the finger (2) Packing the abscess cavity with gauze (3) Skin suture

the perineum. This is deepened to the urethra and the finger inserted into the rectum. With the finger in position, a knife is introduced and Cowper's glands either opened and drained, or isolated and extirpated, as the condition may indicate.

If an abscess is present, a Penrose drain is inserted into the abscess cavity. If the gland is extirpated the Penrose drain is inserted into the cavity whence the gland has been removed. Sounds are then passed into the urethra dilating it well. A perineal catheter is introduced into the bladder through the perineal incision and the wound closed with a single retention suture. Dry dressings are applied and held in place by a split T binder.

**After-care** The perineal catheter is connected to the free drainage apparatus. After 4 or 5 days of drainage the Penrose drain inserted into the cavity is removed and on the fifth day the perineal catheter is removed and a sound passed through the urethra. This usually results in the patient passing most of his urine through the urethra. He may be allowed out of bed on the sixth day. Sounds are passed every week or 10 days for a considerable period.

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## CHAPTER XXIV

### EMBRYOLOGY, ANATOMY, ANOMALIES, AND PHYSIOLOGY OF THE FEMALE URETHRA

#### A EMBRYOLOGY OF THE FEMALE URETHRA

In both sexes, when the embryo has attained a length of between 7 and 11 mm the primitive urogenital sinus, by a process of elongation and constriction, becomes separated into two divisions a dorsal *urethrovesical anlage* and the *pars phallica* (Embryology of the Male Urethra, p 607) From the urethrovesical anlage are formed the urinary bladder and the prostatic and membranous portions of the urethra in the male, but in the female the bladder and the entire urethra develop here The phallic portion extends into the genital tubercle in both sexes, forming the cavernous urethra in the male, but merging with the vestibule in the female

The separation of the bladder from the urethra comes about by a differentiation in cell structure As a result of the rapid cell division preceding the formation of new layers, the urethral cells become smaller and their nuclei lie closer together Consequently, the epithelium of the urethra has a darker appearance than that of the bladder, this change being fully evident when the embryo has reached a length of from 25 to 30 mm

Sex differences are not distinguishable until about the seventh week of intrauterine life, and it is at this period that the female urethra begins to assume its characteristic form When the embryo is about 16 mm long, the female may be distinguished from the male by the shorter length of the urethral groove and the relation of the urethral folds to the labioscrotal swellings (Embryology of the Female External Genitalia p 569) The real differentiation between the male and female external genitalia occurs between the lengths of 38 and 45 mm In the male embryo the phallus now rapidly enlarges and elongates to form the penis, but in the female it lags in development and becomes the clitoris, with its homologous glans clitoridis and prepuce The shorter urethral groove never extends onto the glans, as in the male

## B ANATOMY OF THE FEMALE URETHRA

The urethra in the female is a short, membranous channel leading from the bladder to the urinary meatus, which is situated in the vestibule between the glans clitoridis and the vaginal orifice. Embryologically, the female urethra corresponds to the prostatic and membranous urethra in the male.

**Length and Caliber** The female urethra is notably shorter than the male canal, being only 2.5 to 4 cm long. It has a normal caliber of about 8 mm, the caliber increasing slightly toward the bladder. When collapsed, the longitudinal folds into which the mucosa is thrown give it a stellate appearance in cross section. The wall, although 10 to 12 mm thick in some portions, is very elastic, and this elasticity and the longitudinal mucosal folds make it possible to distend the canal considerably without injury. The external meatus is the narrowest and least distensible portion.

**Topographical Relations** The general direction of the urethra in the female is downward and forward behind the symphysis pubis. Most investigators describe a slight anterior curve at the lower border of the symphysis. W. E. Stevens and S. P. Smith, however, disagree with this, stating that in most of the cases studied by them the urethra was either straight or had a slight *posterior* curvature rather than an anterior bend. In its lower two thirds it is embedded in the anterior vaginal wall, a single thick stratum of tissue being all that separates the lumen of the urethra from that of the vagina, making vaginal palpation of the urethra easy. Anteriorly and on either side the urethra borders on the pubic venous plexus, the corpora cavernosa of the clitoris, and the vestibular bulbs, which impinge upon it laterally in its passage through the triangular ligament.

**Structure** A transverse section of a fully developed female urethra shows two strata: an inner epithelial layer and an outer muscular tunic.

The urethral mucosa lies in longitudinal folds, the most prominent of which, the *crista urethralis*, extends along the urethral floor from the trigone almost to the urinary meatus. The mucous glands, which are tubular and branching, are more numerous in the outer portion. The epithelium is, for the most part, of the squamous stratified type, becoming transitional near the bladder.

Beneath the epithelium, and separating it from the muscle layers, is a fine connective tissue carrying numerous vascular papillae containing lymph nodes. In the deeper portion of the submucosa there also exists a vascular venous network, which extends into the muscle layers.

The musculature of the female urethra is entirely sphincteric, for urinary control, and is best described in connection with the musculature of the bladder (p 950)

**The Meatus** The urinary meatus in the female is a vertical slit, about 5 mm in diameter, situated between the *urethral labia*, two ridges which are more or less prominent in different persons. Externally, the meatus appears as a vertical (sometimes an inverted Y shaped) slit on the summit of a small, rounded prominence about 2 cm below the clitoris

**Blood Vessels Lymphatics Nerves** The *blood supply* of the female urethra is derived from the inferior vesical and branches of the internal pudic arteries. The *veins* drain into the pudic and vesicovaginal plexuses

The *lymphatics* of the female urethra drain into the deep inguinal external iliac, and hypogastric nodes. They are similar in arrangement to the lymphatics of the posterior urethra of the male (p 615)

*Innervation* is from the hypogastric and pudic plexuses

**Glands of the Female Urethra** The largest of the paraurethral glands of the female urethra are Skene's glands. These are two narrow, tubulo-alveolar glands the ducts of which open on the urethral floor just within the meatus. The glands extend inward for a distance of 0.5 to 3 cm. into the lateral wall of the middle third of the urethra. They penetrate practically the entire muscular coat of the urethra. Their terminal alveoli are made up of tall columnar epithelium, and the duct structures close to their outlet are lined by transitional epithelium (Beneventi)

In addition, there are numerous minute glands, mostly compound and racemose, opening by a single duct upon the urethral mucosa. They are located chiefly upon the floor of the urethra in its anterior and middle thirds, and are lined with columnar epithelium of the mucus-secreting type. Near the meatus they are often dilated, forming visible crypts

Regarding the presence of glands in the proximal urethra of the female, there are two different schools of thought. One group believes that there are glands homologous to the prostate in the proximal third of the canal (Virchow, 1863, Tourneaux, 1889, F P Johnson, 1922, Renner, 1931, Folsom, 1931). The other group is of the opinion that there are no glands in the posterior urethra of the female. Chief among the exponents of the latter belief are McKenzie and Beck (1936) and Cabot and Shoemaker (1936), who studied the female posterior urethra thoroughly in a large number of postmortem specimens taken in all decades of life, and found no evidence of glands in this area

The most recent investigation on this subject is the excellent study of F. A. Beneventi (1943) based on material taken from 21 full term infants and 3 seven month premature infants. Only 2 specimens showed definite glands indistinguishable from those in the infantile male prostate, the remaining 21 failing to show any such structures. This rudimentary female prostatic structure is of considerable clinical significance because, as Beneventi points out, "the glandular elements penetrate down to the sphincter muscle, sometimes occupying the cephalic two thirds of the urethrovaginal septum. Consequently, some females can have urinary obstruction because of hypertrophy of these glands with or without infection." The fact that none of the 3 premature specimens showed glandular structures in the posterior urethra indicates that glandular structures usually disappear from the posterior female urethra before the seventh fetal month.

### C ANOMALIES OF THE FEMALE URETHRA

Congenital anomalies of the female urethra although even less common than those of the male canal, have been shown in recent years to be of more frequent occurrence than was formerly supposed. *Hypospadias* and *epispadias* have already been discussed under Anomalies of the Female External Genitalia (p. 578). *Congenital diverticulum* cannot usually be distinguished from the acquired variety, which is considered on page 774. *Congenital stricture* appears to be a fairly common cause of urethral obstruction in the female, and may also be difficult to distinguish from the acquired form.

#### *Absence of the Female Urethra*

Absence of the urethra in the female has been reported in a few instances (Skene, 1887, Rocher and Riviere 1927, L. Fraenkel, 1929), usually in conjunction with other marked congenital anomalies such as exstrophy of the bladder. Partial formation of the urethral walls with atresia of the canal has also been reported.

#### *Duplication and Bifurcation of the Urethra*

A few cases of partial or complete duplication of the urethra are on record. In a previous publication (1926) we mentioned the cases of Pean, Wolfer, and Cozi (cited by Frank), Furst (cited by Herman), and Dannreuther—the last two, complete duplication of the urethra unaccompanied by vesical or other abnormality. In 1936 Schinagel reported a case of partial duplication (bifurcation) in a Negress separate

canals extending from separate meatuses for a distance of 2.5 cm, at which point the two tubes fused and thence proceeded normally to the bladder. Stevens (1936) cites 2 additional cases of partial duplication.

These bifurcated canals must be distinguished from fistulous tracts, which are usually acquired.

### *Anomalous Ureteral Orifices in the Urethra*

Anomalous ureteral orifices in the urethra are occasionally seen. This anomaly causes incontinence in females much more often than in males, in whom the anomalous orifices are likely to be *within* the sphincter (Anomalies of the Ureter, p. 1220).

### *Congenital Obstruction of the Female Urethra*

**Etiology and Pathology** Congenital strictures of the female urethra, contrary to the general impression, are quite common. Most of these are of the external meatus. Differentiation of congenital and acquired strictures may be difficult. Such constrictions usually consist of a circular band of thin but resistant tissue which is generally attached higher up on the inferior margin of the meatus. Some of these bands are too tenuous to cause obstruction or inconvenience, but others constitute true diaphragms or 'valves' such as are quite often seen in male children.

These obstructing bands presumably have their origin as fetal rests of the cloacal membrane. The urethral obstruction may be only partial but is more likely to be complete. The obstructing band may be located in any part of the canal, but is located at the external meatus in a large proportion of cases.

**Symptoms and Diagnosis** Congenital narrowing of the meatus or partial obstruction higher up in the urethra, is undoubtedly an etiological factor in many affections of the female urinary tract. The most frequent symptoms of such obstruction are frequency and urgency. In adults, urethritis is common in the presence of congenital or acquired stricture. Infection in the bladder and kidneys is often seen and there may be dilatation throughout the urinary tract due to retention and stagnation of the urine, which is imperfectly voided because of the contraction and obstruction. Diverticulum of the bladder is probably due in many instances to a congenital stricture of the lower urethra.

It has been pointed out (Boyd) that when congenital narrowing is present there will be a thin walled protruding lower lip or fold perhaps 0.5 cm high and 2 to 3 mm thick, below, with only a slight pocket, or



none at all, back of the circumference of the orifice. In the case of young children, the attention of the mother or attendant may be called to such formations by the fact that when the child is placed upon the urinal the stream spills over the top, due to the urine striking against this lip and causing the stream to be diverted upward. Boyd suggests that this abnormality may be an etiological factor in the pyelitis of little girls, who are much more subject to this affection than boys of the same age.

The average size of the normal adult urethra in the female is No. 26-F. In 174 strictured urethras examined by Stevens, the average size of the lumen at the point of constriction was only No. 21-F. In infants under one year of age the average caliber is normally about No. 12-F. A smaller meatus in a female infant usually requires surgical attention to prevent urinary tract difficulties later in life.

Infants with complete congenital obstruction of the urethra are frequently born dead or expire soon after delivery. If the obstruction is recognized promptly, operative relief may often be afforded without difficulty or danger. The female urethra being short and straight, instrumentation and inspection are easy, even in the newborn, and such examination should always be undertaken in infants and children, as well as in adults who have symptoms suggestive of a pathological condition of the urinary tract. The olive tipped bougie and the urethroscope are best for this purpose.

**Treatment.** The treatment of congenital stricture of the meatus is meatotomy. Obstructions higher up in the urethra may occasionally be removed by dilatation or by finger dissection. Usually, however, diathermy or the knife must be employed. In some cases the mere passing of a baby cystoscope has completely relieved a young infant, as the dilatation caused by its insertion was sufficient to open up the canal for the normal evacuation of the bladder.

#### D. PHYSIOLOGY OF THE FEMALE URETHRA

The function of the urethra in the female is solely the conveyance of urine from the urinary bladder. Retention of fluid in the bladder is dependent upon muscular closure of the canal, and the chief factor in such closure is the involuntary sphincter. The female urethra in its entirety corresponds, as we have seen, to the posterior urethra of the male. The structure, innervation, and blood supply of the urethral wall, and its adaptability to the function of micturition, are practically identical in both sexes.

The physiology of micturition including the important role played by the urethra, is described under Physiology of the Bladder (p 974)

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## CHAPTER XXV

### INJURIES AND DISEASES OF THE FEMALE URETHRA

The urethra is gradually receiving long deserved recognition as a cause of many chronic urinary disturbances in women. Anomalies and injuries, with the exception of trauma incurred during childbirth, are infrequent, but chronic urethritis, stricture, tumors, and prolapse are common. The urethral glands, lacunae, and crypts are very often the overlooked culprits in the chronicity and exacerbations of gonorrheal and non specific urethritis and the resulting urinary disturbances.

The bladder and urethra are frequently involved in birth injuries. Subsequent infections due to the gonococcus or other infectious agents, are common. Every gynecologist is familiar with simultaneous cervicitis and cystitis and when the bladder is involved the urethra is likely also to be affected. The close anatomical relation between the urinary and genital canals of the human female makes it probable that infection in one tract will be quickly communicated to the other. The frequency of such associated pathology, and the similarity in symptomatology often existing in diseases of the female urinary and generative organs are frequently responsible for confusion in diagnosis. It is important, therefore, that the gynecologist and urologist cooperate in the care of these borderline conditions in which examination of both the urinary tract and the generative organs is often necessary.

Chronic infection of the female urethra is more common than is generally appreciated. If the external meatus is placed high in the vaginal introitus, a region peculiarly exposed to bacterial invasion and generally bathed in infected secretions its liability to infection is enhanced, particularly if the meatus is congenitally narrowed so that free drainage is interfered with. Urethral prolapse especially favors infection of the exposed mucosal lining of the canal, as the surface is certain to become excoriated. Less frequently the urethra may suffer injury through normal coitus, masturbation, or abnormal practices, all of which may induce chronic irritation leading to infection of the traumatized mucous membrane.

Generalized infections, such as syphilis, may be responsible for local

lesions in the urethra Syphilitic involvement of the spinal cord, producing the so called "cord bladder," may so disturb bladder function as adversely to affect the urethra, and the same is true of multiple and lateral scleroses Focal infection, in regions of the body remote from the urinary tract, may set up interstitial cystitis and urethritis

The direct local effects of such chronic infections appear through the urethroscope as diverticula, sclerosis of the bladder neck, contraction and sclerosis of the urinary meatus, inflammation of Skene's ducts, and granular, polypoid, or cystic changes Occasionally a single attack of acute urethritis may produce such lesions, but usually they are the result of long standing chronic infection

For use in the female urethra we have found the Butterfield female urethroscope (Figs 3 to 6) a most valuable instrument

### A INJURIES OF THE FEMALE URETHRA

Injuries of the female urethra, apart from those produced in child birth, are uncommon The urethra's relative immunity to external trauma in the female is due to its protected location beneath the pubic arch Straddle injuries and rupture or puncture of the urethra by fragments of fractured pelvic bones have occasionally been reported, but such accidents are rare Because the canal in the female is short and straight, injury from instrumentation seldom occurs In rare instances the urethra is injured by coitus or in surgical interventions upon the vagina

The most prolific source of urethral trauma in women are the accidents of labor The severe and often prolonged pressure to which the urethra is subjected may result in contusions or even tears of the muscle fibers and mucosa Stricture, urethral prolapse, urethrovaginal fistula, urethrocele, and partial incontinence due to weakening of the musculature and sphincters are the more common sequelae In one of Kirwin's cases the urethra was torn from its normal location during a severe labor and pulled to one side In addition to the dislocation and injury of the urethra, there was a vesicovaginal fistula with complete avulsion of the bladder through the fistulous opening The perivaginal fascia one of the chief supports of the bladder, is frequently injured during labor or in the course of pelvic operations, resulting in a curvature and angulation of the urethra which alters its relation to the trigone The recognition and correction of such injuries are of great importance as they may lead to grave urological lesions productive of years of suffering

Relaxation of the vesical sphincter is frequently a complication of cystocele, and is seen in multiparae and in women who have passed through a severe labor. It is due to loss of tonicity of the muscles of the vesical neck. The patient usually complains of inability to hold her urine if she coughs or sneezes suddenly, is frightened or hurried, or laughs unrestrainedly. If relaxation of the sphincter is considerable, there may be constant loss of small amounts of urine, necessitating the wearing of a pad.

Complete sloughing away of the urethra has been reported in a few instances (Hayes, 1932, Harris 1935). In 2 of the 5 cases seen by Harris the destruction was due to sloughing following childbirth, and in the other 3 was the outcome of the surgical treatment of carcinoma of the urethra by resection, diathermy, or radium, used either alone or in combination.

Surgical procedures for the relief of urinary incontinence in the female are described under Surgery for Incontinence of Urine (p. 1137).

## B DISEASES OF THE FEMALE URETHRA

### *Non-Specific Urethritis*

**Etiology** Non specific infections of the urethra are commoner in the female than in the male. The same types of bacterial invasion affect both sexes, notably those due to colon bacilli and streptococci.

The proximity of the urethra to the vagina and rectum makes easy the communication of infection from these passages to the urethra. An acute urethritis may be set up by traumatism of the urethra due to difficult labor, by prolonged, too vigorous, or too frequent instrumentation, by the use of improperly sterilized catheters or other instruments, or by the presence of other foreign bodies, such as a calculus. Focal infection elsewhere in the body (tonsils, sinuses, teeth) may set up an interstitial urethritis. Dietary errors, highly acid urine, and alcoholic excess have all been put forward as etiological factors. The urethral changes may be secondary to cystitis. A constricted meatus, by interfering with free drainage, predisposes to infection. In many cases the origin is indeterminate. The health may be excellent except for the urethral symptoms, and there may have been no preceding illness or disability that can be attributed as a cause.

Chronic non specific urethritis is usually the aftermath of an acute inflammation. In addition to the larger glands of Skene, there are many small glands and lacunae in the proximal and distal thirds of the female

urethra Overlooked or inadequately treated infected glands, lacunae, or diverticula are usually responsible for the persistence or recurrence of urethritis in the female

**Pathology** In acute urethritis the inflammation is usually diffused throughout the entire mucous membrane of the canal The inflammatory changes of chronic urethritis are limited as a rule to the deeper portions of the urethra and the bladder neck or to the distal third of the canal Clinically, the changes in the mucous membrane appear as infiltrations of the periurethral tissues, sclerosis of the bladder neck or urinary meatus, polypoid masses, granulomas, or cystic changes Extension of the urethral inflammation to the trigone and about the vesical neck is common, and there is frequently an associated cystitis

**Periurethral Abscess** A diverticulum or urethrocele may form a convenient lodging place for invading organisms, and may be the origin of a *periurethral abscess* Such a pus filled pocket can be palpated in the vaginal introitus but inspection will show the sac to originate in the urethrovaginal septum The condition may easily be mistaken for a cyst, but pressure upon the sac by the examining finger will usually cause pus and urine to appear at the meatus Abscesses may also form in infected glands, the orifices of which have been occluded by mucous secretions or inflammatory swelling walling off the infectious process Such abscesses may rupture spontaneously

**Symptoms and Diagnosis** The chief symptoms of non specific urethritis are frequency of urination, burning and urgency, nocturia, sensation of incomplete emptying of the bladder, and pain referred to the back or along one or both ureters Pyuria occurs in about one third of the cases, gross hematuria less frequently Marked nervousness is the rule The sensation of incomplete emptying of the bladder usually indicates the presence of polypoid masses

The diagnosis of non specific urethritis is made by the cysto urethroscopic disclosure of inflammatory changes in the urethra and the exclusion of disease elsewhere in the urinary and genital tracts The small glands and lacunae of the urethra should always be subjected to minute inspection in the effort to locate the infective foci responsible for a persistent or recurrent urethritis It should be borne in mind that the orifices of Skene's ducts are occasionally located outside the urinary meatus and that additional paraurethral ducts and glands are sometimes found external to the urethral orifice Palpation of the urethra through the vagina will usually locate areas of special tenderness or infiltration

Differentiation between the inflammations produced by various bacteria requires bacteriological examination. The type of bacterium should always be determined.

**Treatment** The symptoms of acute non specific urethritis usually subside rapidly upon removal of the cause (cessation of instrumentation, removal of calculus, correction of errors in diet, treatment of focal infection). In many cases however, a complete cure does not take place, and the subjective symptoms recur after a time.

*The treatment of chronic urethritis is, in general, the same whether the inflammation is produced by the gonococcus or some other organism.* The older methods of irrigation and the local application of silver nitrate have largely given way to gradual dilatation of the urethra, fulguration, and sulfatherapy.

Occasionally only one or two dilatations may be required, but more often the urethra must be dilated weekly until the desired caliber is reached, and then at gradually increasing intervals over a considerable period of time in order to maintain this caliber.

After the pus has been expressed from its hiding place in ducts and urethral follicles, the emptied recesses may be safely and rapidly cauterized with the actual cautery or the high frequency current. The treatment of infective foci by the application of phenolglycerine is also effective. Polyps and granulomas are best treated by superficial fulguration. Several treatments may be required for their removal. Large diverticula may require surgical removal depending upon their location and the extent and chronicity of the infection.

Bladder lavage, sitz baths, alkalis, and urethral suppositories are usually beneficial. Pure sterile glycerine may be instilled into the urethra thrice weekly by means of a glass syringe and rubber catheter, or applied directly with a coated probe.

The newer drugs of the sulfonamide group—sulfathiazole and sulfadiazine—are of decided value in the treatment of non specific urethritis, although the various types of organisms do not react to the same extent.

Extraurethral foci of infection, particularly in the cervix, should be eradicated in order to prevent relapses.

### *Gonorrheal Urethritis*

Gonorrhea is a much more serious disease in women than in men, due to the greater seriousness and frequency (30 to 40 per cent) of complications and the difficulty of eradicating all foci of infection and effecting a

cure once the disease has involved the fallopian tubes. Many women are infected innocently, contracting the disease from their husbands. Frequently these women are ignorant of the true nature of their trouble, and the consequences (often sterility and semi invalidism) are seldom attributed to the real cause. Fortunately, gonorrhea is much less common in women than in men. The incidence is usually in direct ratio to the density of the population, and has been variously estimated at from 2 to 20 per cent of adult females.

The reader is also referred to the sections on Gonorrheal Vulvitis (p 585), Vaginitis (p 594), and Vulvovaginitis in Children (p 591), as well as to the chapter on Gonorrhea in the Male (p 701), much of which is pertinent to the female also.

**Modes of Transmission.** The disease is usually transmitted by sexual intercourse, but may be conveyed through contact with infected towels, instruments, linens, and other objects. A man exposed to gonorrhea may sometimes escape infection, but a woman will almost invariably contract it unless proper prophylactic measures are successfully used.

**Bacteriology.** Same as in the male (p 705).

**Pathology.** The urethra is involved in at least 50 per cent of all cases of gonococcal infection in the female, in fact, the dysuria, frequency, or even hematuria accompanying an acute gonorrheal urethritis may be the first clinical symptoms to announce the presence of an infection. In the majority of cases infection of the cervix is primary, the urethra becoming secondarily infected from the vaginal discharge. Primary infection of the urethra is, however, a common occurrence. Skene's ducts and Bartholin's glands may also be infected primarily.

Acute urethritis in the female differs somewhat in its manifestations from that in the male. The involvement of both the anterior and posterior portions of the urethra, as well as the trigone, is common. At the outset the inflammation is confined to the surface, the organisms attacking the mucous membrane and the submucosa. All gonorrhea tends, however, to become chronic, gradually penetrating to the deeper structures. The organisms may remain dormant for long periods, to be excited into virulence by some congestion, such as that attending child birth, by sexual or alcoholic excesses, or by inflammation caused by other pus forming organisms.

Gonorrheal urethritis is usually accompanied by an extension of the infection into Skene's ducts and the periurethral glands, greatly contributing to the maintenance of a chronic urethritis. Abscess formation in Skene's ducts and Bartholin's glands is common.



Gonococcal cystitis is much more frequent in the female than in the male and may be the sole reason for medical consultation. Infection of the posterior urethra and occasional rudimentary glands located at the vesical neck may maintain an apparent "chronic cystitis" without involvement of the bladder proper. Since the clinical signs caused by such infection of the entire urethra are similar to those of cystitis, errors in diagnosis may result.

Although vulvitis and vaginitis are uncommon in the adult, the glands of Bartholin on each side of the vaginal introitus are usually involved. The cervix is also frequently infected, either primarily or later in the course of the disease, and in at least one third of the cases there is involvement of the adnexa—a most serious complication which frequently endangers the patient's life and usually necessitates surgical intervention. Such involvement of the adnexa almost invariably results in sterility, and Pelouze estimates that at least 40 per cent of all operations upon the uterus and adnexa are for lesions of acute or chronic gonorrhea. Prevention of tubular involvement is therefore of paramount importance.

**Symptoms.** The clinical signs and symptoms of acute gonorrheal urethritis may vary considerably in the female. A slight burning on urination may be the only symptom. This may disappear quickly and be speedily forgotten. If the inflammation is not very severe, a woman may pass through an acute gonorrhea in complete ignorance of the fact that she has been infected with a serious venereal disease. Later pelvic complications are unlikely to be in any way related by the patient to this mild initial symptom.

As a rule, however, there is pronounced burning on urination, some frequency, a urethral discharge, and sometimes hematuria. There may be rapid invasion of the genital tract, accompanied by severe constitutional symptoms, or the disease may be insidious in its course, the acute stage subsiding rapidly and usually passing into a chronic stage, in which urethral exacerbations are likely to occur. If menstruation supervenes *during the acute stage, the infection is almost certain to be communicated* from the cervix to the fallopian tubes unless stringent preventive measures are taken. Pelvic involvement often results in permanent impairment of health and vitality, menstrual disorders, and chronic invalidism.

**Diagnosis.** Inspection of the urethra in the acute stage will usually show pus issuing from the urinary meatus, making it easy to obtain a specimen for examination. Abscess formation in Skene's ducts and the periurethral glands is common, and if these have attained any size they will, on palpation, give a sensation as of tender, pea like nodules lying

beneath the urethra or in its immediate neighborhood. The entire urethral region will be so painful that the examiner will be obliged to proceed very carefully. Instrumentation, even the passage of a soft rubber catheter, is contraindicated in the acute stage.

When inspection has been completed and a smear obtained, the two glass urine test should be employed.

Urethral smears in the acute stage are of great diagnostic importance, because at this stage secondary organisms are usually absent and identification of the gonococcus easy. In the chronic stage, however, it may be almost impossible to find the gonococcus, making the diagnosis one of the most difficult of clinical and bacteriological problems. Negative smears from the urethra, cervix, or glands of Bartholin are of no significance whatever in the presence of pus. Only after repeated culturing and months of observation have failed to reveal evidence of gonococcal infection should a case be declared non gonorrheal. Examination in every case should include careful investigation of the urethra and Skene's ducts, Bartholin's glands, and the cervix, and, if conditions indicate, pelvic examination to determine the presence or absence of salpingitis. In the chronic stage, the intelligent use of the urethroscope is of the greatest help in revealing hidden foci of infection in the folds, crypts, and glands of the urethra, where the organisms harbor most persistently.

**Prophylaxis.** The ordinary vaginal douches are far from satisfactory. An effective method, if employed within one hour after exposure, is the packing of the vagina with gauze saturated in a 10 per cent solution of argyrol, or rivanol dextrose, 2 per cent, or acriflavine, 2 per cent.

**Treatment. Acute Gonorrhea.** In general, treatment of acute gonorrhea in the female consists in rest, cleanliness of the genital region, sulfonamide therapy, and measures to prevent spread of the infection.

Rest is the most helpful agent in promoting recovery from the acute stage. As a rule, active local measures are harmful. Menstruation during the acute stage increases the likelihood of the disease spreading upward to the adnexa. Absolute rest in bed and the application of a cold compress to the lower part of the abdomen will help to check the inflammation and may save the patient from an acute infection of the fallopian tubes and ovaries.

A bland, non irritating diet, the interdiction of alcohol in any form, and an abundance of fluids, so as to dilute the urine as much as possible, should be insisted upon. It is important to avoid constipation at all times, but particularly during the menstrual period, because constipa-

tion induces congestion of the pelvic veins, which may favor extension of the infection to the adnexa

*Local treatment* consists in keeping the parts clean and in the application of soothing compresses. A douche should never be given to a woman in the acute stage of gonorrhea, as this may carry the germs upward to the higher structures. The parts should be kept as clean as possible with warm water and a mild soap, and frequent use made of shower baths in preference to the full or sitz bath.

The irritated skin and mucous membrane may be bathed with a silver solution such as argyrol, 10 per cent or protargol, 2 per cent, keeping the surfaces constantly moist. In drying the surfaces, it is important to pat, not rub, them. A 3 per cent solution of aluminum acetate is another efficient remedy. Sterile gauze is saturated with this and laid over the inflamed vulva and urinary meatus. A fold of gauze, dampened in the solution and laid between the labia, will ease the pain by keeping the inflamed surfaces from touching each other.

Forceful treatment of the urethra during the acute stage is to be strongly disapproved.

Bickers, of the Medical College of Virginia, has had excellent results in the prevention of complications and the cure of acute gonorrheal infection by the use of sulfonamide locally in the form of boroglyceride suppositories, using 20 gr of sulfonamide and 10 gr of lactose in the suppository. One sulfonamide suppository is inserted high into the vaginal vault 3 times a day. Treatment is continued for 17 days, smears from the urea and cervix being taken bi weekly. In 25 adult patients thus treated, the results were as follows. Smears from the urethra and cervix were negative in all 25 at the end of 1 week, 19 of 21 patients who were followed for 3 months were symptom free without evidence of urethritis, and with not a single case of Bartholinitis, salpingitis, or endocervicitis, 1 patient, at 3 months, had a reinfection acquired 5 days previously, but had been symptom free up until the onset of this reinfection, 1 patient had a residual endocervicitis.

*Internal medication* was of little value in either acute or chronic gonorrhea until the introduction of the sulfonamide group of drugs. While not specific for gonorrhea, these are undoubtedly the best chemicals for the treatment of neisserian infection yet placed at our disposal. Sulfanilamide and neoprontosil, the older drugs, both proved useful in the management of gonococcal infections in the female, but their administration, unfortunately, was frequently accompanied by unpleasant and

even dangerously toxic effects. They have now been largely supplanted by newer compounds of considerably lower toxicity, although of equal, or even greater, efficiency, such as sulfathiazole, sulfadiazine, and sulfa pyridine (see Sulfanilamide and Related Compounds, p. 1162).

Not only have these drugs been found valuable in shortening the duration of the infection, but if taken early enough in the acute stage of gonorrhea (before the onset of menstruation), they materially reduce the chance of complications.

Sulfathiazole and sulfadiazine are, at present, preferred for the treatment of gonorrhea. Usually, 2 to 3 Gm. daily, in 4 doses—one after each meal and one at bedtime—accompanied by 1 Gm. of sodium bicarbonate, is satisfactory. Treatment is continued for from 5 to 10 days if the patient tolerates it well. In chronic infections a second course, of similar dosage and duration, may be given after a rest period of a week or 10 days, if necessary.

If there are no signs of improvement at the end of a 10-day course of the therapy, the patient may be considered resistant to the particular sulfonamide in use, and other treatment should be instituted.

*Chronic Gonorrhea* Local treatment of the chronically infected urethra consists in urethral dilatations, bladder irrigations with antiseptics such as rivanol dextrose, 1:5,000 or acriflavine, 1:5,000, and the use of urethral suppositories containing silver salts. Protracted and recurrent cases of urethritis should always be investigated through the urethroscope for hidden foci of infection in the glands and lacunae, which will explain the chronicity in many cases. The paraurethral ducts and urethral follicles may be destroyed by electrocoagulation or by tiny beads of silver nitrate on a needle introduced into the glands to their entire depth.

After the acute infection has subsided, local treatment of the cervix consists of the use of cervical suppositories containing various concentrations of silver salts, accompanied by antiseptic packing of the vagina. Other therapeutic measures that have received the sanction of urologists include cauterization, conization, and ionization of the chronically infected cervix, where the gonococci may linger long after their eradication from the rest of the genital tract.

Chronic Bartholinitis is best combated by surgical removal of the entire gland (p. 603).

Diathermy is valuable chiefly in the treatment of chronic salpingitis, oophoritis, and parametritis. Pathological changes in the fallopian

tubes and ovaries and adhesions between the pelvic organs, resulting from gonorrhea, represent surgical problems outside of urology

**Criteria of Cure** It is even more difficult to be certain of cure in women than in men. Smears are of no importance and even cultures are of limited value. The absence of pus in the secretions from the cervix, urethra, and Bartholin's glands, together with a negative complement fixation test, is a more reliable criterion of cure. Complement fixation tests showing a reversion from positive to doubtful and negative should be considered unquestionable evidence of cure. The fact that a sero positive syphilis will render the complement fixation positive must be taken into consideration.

Any pronouncement of cure in the chronic cases should be made only after a prolonged period of observation ranging from 6 to 12 months, during which time monthly check ups have been undertaken without the patient having had the benefit of any curative measures.

### *Syphilis of the Female Urethra*

**Chancre** Chancre of the urethra is a far less frequent occurrence in the female than in the male. It is most likely to be found at the lower edge of the urinary meatus or, if intraurethral, in the anterior portion of the canal. The chancre appears as a red, angry looking erosion, covered with a scanty seropurulent exudate and surrounded by a wide zone of induration.

A *meatal chancre* will cause the urinary orifice to be puffed out, misshapen, gaping, and markedly indurated. The induration may be so extensive as to obstruct the orifice, causing retention of urine. The indurated area sometimes extends for a considerable distance up the canal, and when making an examination, one should separate the urethral labia and conduct a thorough search. The extensive induration is suggestive of malignancy and the differential diagnosis may sometimes be difficult.

*Intraurethral chancre*, in both sexes, has two prevailing symptoms—discharge and induration. On the appearance of the discharge a man will frequently seek medical advice, believing that he has been infected with gonorrhea, but with women such a manifestation is likely to cause little alarm and no notice may be taken of anything unusual until induration and, in some cases, slight pain during micturition direct attention to the urethra. Since the chancre is almost always located in the anterior portion of the urethra, it is generally possible to palpate the in-

durated area. There is usually an accompanying swelling of the inguinal glands.

**Secondary and Tertiary Lesions** Both secondary and tertiary lesions of the urethra are rare although Tanton found tertiary lesions to be commoner in women than in men. The majority of these gummatous syphilids of the urethra are probably secondary to lesions in adjacent tissues. Gummatous ulcers of the vulva may undermine and partially destroy the urethra and if such destruction involves the sphincter incontinence results. The extreme degree of induration always noticeable in the urethral tissues of the tertiary lesions as well as in the initial chancre, has often been stressed.

**Diagnosis** The diagnosis of syphilis must finally rest on the demonstration of *Spirochaeta pallida* in the exudate from the chancre by repeated dark field examinations and on Wassermann tests upon the blood and spinal fluid (see p. 268). The condition with which syphilis is most likely to be confused is malignancy. It must be borne in mind that a positive Wassermann reaction merely indicates that a patient has had syphilis, and that it is perfectly possible for a syphilitic to develop malignancy. Where there is real doubt regarding the presence of malignancy examination of a specimen removed at biopsy is the safest procedure.

**Treatment** Treatment is antisyphilitic (p. 270). Stricture resulting from syphilitic induration and incontinence due to involvement of the sphincter require special treatment.

### *Tuberculosis of the Female Urethra*

Infection of the female urethra by the tubercle bacillus is very rare. Medical literature is almost silent upon the subject.

Involvement of the urethra in the female as in the male is probably secondary to tuberculosis elsewhere in the urinary or genital tract in most instances. For the pathological changes in the urethra, symptomatology and treatment the reader is referred to the section on Tuberculosis of the Male Urethra (p. 639).

### *Benign Tumors of the Female Urethra*

#### POLYP PAPILLOMA

**Pathology** Proliferative changes of the urethral mucous membrane in the form of polyps and papillomas are frequent in the female. They are important in diseases of the female urethra since they give rise to very distressing symptoms and are often difficult to detect. They may

occur in any part of the urethra, but are especially to be found about the vesical neck and in the vicinity of the urinary meatus. The outgrowths may be merely threads of tissue, or they may be so numerous, or of such size, as to obstruct the lumen. They are commonly attached by a pedicle, which may elongate to such an extent that the growth presents at the meatus. There is usually an associated chronic urethritis.

**Symptoms and Diagnosis** One or more of these excrescences may be present without producing symptoms. Commonly, however, they give rise to *exceedingly distressing manifestations out of all proportion to their size*. Growths arising in the region of the internal sphincter are particularly likely to produce severe symptoms such as painful and frequent urination, vesical tenesmus, and hematuria. Proliferations about the vesical neck are usually readily observed through the cystoscope or urethroscope, but when they occur in the urethral canal itself it is easy for them to escape detection, since they are often concealed in the deep mucosal folds. Urethroscopy, preferably with one of the air distention instruments, is the only method of detecting them. The exquisite sensitiveness of the affected portion of the urethra frequently makes any instrumentation very painful, requiring generous anesthetization of this area.

**Treatment** Polypoid and papillomatous growths are readily removed with one of the high frequency cutting instruments, with small likelihood of recurrence. This method is preferable to cold excision, which usually results in profuse bleeding.

#### CARUNCLE

Caruncle is peculiar to the female urethra, no similar growth being encountered in the male. It is found at all ages, but is rare under 20 years and commonest after the fortieth year.

**Etiology** The etiology is obscure. Some writers attribute these growths to irritation and infection, and believe them to be most common to women who have had gonorrhea.

**Pathology** The exquisitely sensitive, raspberry like tumor usually protrudes from the posterior lip of the urinary meatus, and may be sessile or pedunculated—usually the former. Two types of tumors have been grouped under the term *caruncle*: (1) granulomas and (2) new growths. Neuberger found each of the 12 specimens examined by him to be a granuloma. He distinguished three varieties: (1) granuloma (due to chronic inflammation) (2) papillary angioma (3) telangiectatic non

**papillary mucous polyp** Lange, on the other hand, found 39 of the 58 caruncles studied by him to be new growths and 19 granulomas. The histological differentiation may sometimes be difficult and is of little clinical importance since all tumors at the urinary meatus give similar symptoms, are potentially malignant, and require removal. Young, of Boston, found 5 out of 19 tumors removed under the clinical diagnosis of caruncle to contain definitely carcinomatous tissue. Williamson and Atlee have seen 2 cases of primary carcinoma of the urethra, in both of which a vascular caruncle had been previously removed, and there have been other reports of malignant recurrences.

**Symptoms** The chief characteristics of most urethral caruncles are their vascularity and exquisite painfulness. In milder forms pain and dysuria may exist for long periods before causing the patient to seek medical assistance. In the severer types the caruncle may lead to such distress through pain, micturitional frequency and painfulness and hemorrhage that the patient's morale will be completely broken.

Many years ago William Goodell, one of America's great gynecologists, left us this picture of urethral caruncle as he presented it to his students at the University of Pennsylvania:

As I expose the meatus urinarius those of you on the lower benches can see, peeping out of it a small crimson and wart like body. It is called urethral caruncle vascular tumor and vascular excrescence of the urethra. I hook up the base of the growth with a tenaculum and by very gentle traction bring it wholly to view. It now looks like a small Antwerp raspberry and shows a broad base of attachment just within the lower verge of the meatus. Insignificant in size as this little growth is it has embittered this woman's life for the past four years. Notice its vascularity it bleeds on the slightest touch. Remark also its extreme sensitiveness although profoundly anesthetized the woman winces and draws up her limbs. So exquisitely alert are the little nervelets distributed over its surface that were she not under the influence of ether she would writhe under the brush of a feather. You must not infer that every case of caruncle presents symptoms as exacting as these. In the majority of cases there is no constitutional implication and the woman complains merely of discomfort or of pain during the acts of micturition and of coition. But on the other hand worse cases will be met with—cases in which by loss of rest constant suffering and endless brooding insanity has been induced. Some women have even been goaded by their anguish into committing suicide.

**Diagnosis** The diagnosis is made on histological examination of removed tissue. Malignant growths are chiefly to be differentiated.

**Treatment** Excision by means of the high frequency current has now replaced all the older methods of treatment. Ability to urinate without much pain immediately after the operation, and rapid healing, are the rule, and the likelihood of recurrence is less than with the older methods.



of excision and destruction by various cauterizing agents. Local anesthesia is often used, but the extreme sensitiveness of many of these growths may make spinal or general anesthesia necessary.

#### FIBROMA MYOMA FIBROMYOMA

Benign tumors of the urethra originating in connective and muscular tissue are uncommon in the female. Fibroma, myoma, and fibromyoma have all been reported, but because of their rarity are of little clinical importance. Such growths may reach a considerable size and, by constricting the urethral lumen, interfere with urination.

**Treatment.** Very small growths may need no treatment. Larger tumors, interfering with urination or coitus, require excision.

#### *Malignant Tumors of the Female Urethra*

##### CARCINOMA

Primary carcinoma of the female urethra is relatively rare. Lazarus and Schneider (1936) found 150 cases on record, including the one presented by them. These figures differ from those of Sparks and Parsons who, in a very complete review of the literature in 1937, were able to tabulate only 119 authenticated cases. Vulvo urethral carcinoma is much more common.

**Etiology.** Chronic irritation appears to be a predisposing etiological factor. Urethral caruncle preceded the malignancy in not a few of the reported cases. Secondary invasion of the urethra from carcinoma originating in the vulva, vagina, or bladder is more frequently observed than primary growths of the urethra.

**Pathology.** Squamous cell carcinoma is the most common type, but adenocarcinoma arising in Skene's glands has been reported. The lesion may be of the infiltrative or the ulcerative type.

**Symptoms.** There is nothing pathognomonic in the local manifestations. Hematuria, frequency, and dysuria, and a tumor at or near the meatus are the outstanding symptoms. In the later stages there is occlusion of the urethra with severe pain on urination, but in the earlier stages the growth is painless and is therefore likely to escape notice. Since most of the patients are first seen late in the development of the tumor, there is likely to be evidence of lymphatic involvement.

**Diagnosis.** Inspection of the tumor is usually not difficult, since the majority involve the anterior segment of the urethra or the meatus. Biopsy is the only means of definite diagnosis.

**Differential Diagnosis.** Most authors regard the diagnosis as easily

made, only syphilis and benign neoplasm causing any confusion. These conditions may, however, cause the diagnostician considerable trouble. It has already been noted that frequently growths removed under the clinical diagnosis of caruncle have been found to contain definitely carcinomatous tissue. In one of the reported cases the final diagnosis of the pathologist was "urethral inflammatory caruncle growing from an adenocarcinoma of the urethra."

**Treatment and Prognosis** Several types of treatment have been advocated, including surgery, diathermy, radium, and deep x ray—either alone or, more often, in combination. The high degree of malignancy of these tumors, the late stage at which they are usually first seen, and the advanced age of many of the patients make the prognosis in most cases poor. Some excellent results have, however, been reported from time to time in earlier observed cases.

A summary of the opinions of various authors who have written on malignancy of the female urethra during the past 5 years would indicate that destruction of the primary tumor should be by radium, x ray, or surgical excision (preference being in the order named), with surgical removal of the related inguinal nodes, even if there is no apparent involvement, and postoperative irradiation by radium or deep x ray.

The preferred treatment it seems to us is as complete removal of the primary tumor as possible by excision followed by implantation of radon seeds in the base of the tumor. If the inguinal nodes are involved, they should be surgically removed and deep roentgen therapy applied postoperatively. Deep x ray should be applied to the inguinal regions even if they are not apparently involved, as a precautionary measure. We prefer the implantation of gold radon seeds at the base of the tumor to surface applications of radium because it causes less necrosis and sloughing and distributes the action of the rays evenly throughout the entire growth.

Radical removal of the urethra is usually done only as a last resort since this necessitates transplanting the ureters.

Radium without surgery has been successfully used in some cases (Radiation of the Female Urethra, p. 1744).

#### SARCOMA

Sarcoma of the female urethra is much rarer even than carcinoma, only about 20 cases having been reported in medical literature to date. It may involve any portion of the canal. Metastasis to the inguinal

lymph nodes occurs early and may be the first sign to call attention to the growth

Treatment is the same as for carcinoma. As with sarcoma elsewhere in the urinary or genital tract, the prognosis is always most grave.

### *Stricture of the Female Urethra*

**Incidence** Stricture of the urethra in the female, although rarer than in the male, is not uncommon. Stevens (1936) found strictures of the urethra in 458 of 1,227 female patients with urinary symptoms, or 37 per cent. The female urethra requires, but seldom receives, the same exactitude of exploration that is accorded the male canal. Urethral symptoms in women are common, but are usually attributed to cystitis or otherwise explained. Except in cases of exceptional severity, the urethra is likely to be disregarded in the routine examination of female patients and many narrowings of the canal doubtless thus escape notice.

Measurements of the female urethra made by various investigators show that the normal meatus (the narrowest portion of the urethra) measures from No. 18 to 30 F, that the majority are from No. 23 to 30 F, and that the average caliber of the normal urethra in adult females is No. 26 F. Urethras with calibers smaller than this are undoubtedly often responsible for persistent chronic infection in both the urethra itself and the upper urinary tract.

**Etiology and Pathology** Such abnormal narrowings may be either congenital or acquired.

*Congenital strictures* are discussed under *Anomalies of the Female Urethra* (p. 752). They are almost always limited to the urinary meatus.

*Inflammatory strictures* comprise most of the acquired narrowings. These are mostly postgonorrheal, but healed tuberculous or syphilitic ulcerations are occasionally responsible. Postgonorrheal strictures usually occur before the age of 50, and the majority are located either at the external meatus or in the anterior third of the urethra. As a rule, gonorrheal urethritis induces a localized thickening of the urethral wall, while syphilis is more likely to produce induration and contraction of the canal as a whole.

*Traumatic stricture* is generally due to injury to the urethra sustained during childbirth, although operative or coital trauma, or injury caused by caustics, rough instrumentation, or the passage or lodgment of a calculus may be the causal factor.

*Spasmodic stricture*, caused by involuntary contraction of the urethral musculature, is occasionally found in women, as in men

In the so called *senile stricture* sometimes observed in elderly women there is induration of the entire urethra, causing narrowing of the lumen throughout its length. The narrowing is sometimes so marked that it may be impossible to pass a fine bougie. The condition has been considered analogous to senile hypertrophy of the prostate.

The fibrotic or cicatricial tissue causing the acquired stricture may involve a segment or the entire circumference (annular stricture) and may extend for a greater or less extent along the canal longitudinally. Strictures of the female urethra are usually single, but multiple narrowings are sometimes encountered.

**Symptoms and Diagnosis.** Patients commonly give a history of gradually increasing frequency and dysuria, with straining during micturition, and a sense of incomplete evacuation of the bladder. There may be dribbling at the end of urination. If these conditions are of long standing, pyuria, hematuria, pain in the bladder, and other evidences of urinary retention and infection may be present.

The strictured area can often be palpated vaginally. Definite diagnosis is made by the use of olivary bougies and the urethroscope. A No 23 F bougie should pass to the bladder without resistance. The utmost gentleness must be employed. If the first instrument inserted fails to pass with ease, it must be withdrawn and one of smaller caliber substituted until a bougie small enough to pass the obstruction is introduced.

No examination should be regarded as complete without urethroscopy. The urethroscope will show the pale cicatricial tissue, and it may be possible, through the urethroscope, to locate the constricted portion of the lumen and pass a filiform. A stricture may be impermeable to the passage of any instrument, but no constriction should be declared impassable until an attempt at urethroscopy and the passage of a filiform has been made.

Urethrography, by the injection method is also a valuable aid for the detection of narrowings of the canal and for the differentiation between stricture and narrowing of the entire urethra.

Differentiation must also be made from obstruction due to polyps, caruncle, malignant disease, or extrinsic pressure upon the urethra. Differentiation of congenital and acquired strictures of the urinary meatus may be difficult.

**Treatment.** Treatment is by careful dilatation with sounds or bougies

until the average normal caliber (No 26-F) is reached and maintained. The initial dilatation may be somewhat difficult, but after that has been accomplished, patience and regular dilatation will effect a cure in most cases.

Dilatation should always be carried out under strict aseptic precautions. Local anesthesia is usually satisfactory. The dilatation should be begun with the largest sound or bougie that can be passed, and repeated weekly (increasing no more than two numbers a session) until an approximately normal caliber is attained. Thereafter, dilatation should be done at gradually increasing intervals over a period of at least 2 years. If the stricture has been at all tight, occasional inspection and dilatation should never be entirely abandoned.

Meatotomy may be necessary for narrowing at the meatus, and is sometimes required before urethroscopy or cystoscopy can be undertaken.

Internal urethrotomy is contraindicated as a rule, but is sometimes necessary in cases of impassible or resilient stricture, or when immediate enlargement of the urethral caliber is necessary. Repeated dilatation is of the greatest importance after internal urethrotomy, to prevent recontraction of the incised urethra.

### *Prolapse of the Female Urethra*

Prolapse of the urethra in the female varies from a slight protrusion of the urethral mucous membrane through the external meatus to downward displacement of the entire urethral body. The latter is rare.

**Incidence.** Urethral prolapse is seen most commonly in young girls, next, in women over 40 years, and in only a small percentage of cases in the child bearing period.

**Etiology.** It may develop suddenly, or slowly and progressively.

Many possible etiological factors have been advanced: long standing constipation, with straining at stool, persistent diarrhea, violent coughing, rape, a blow on the abdomen. Emmet believed the condition to be due to injuries of the periurethral and vesical neck tissues by the passage of the fetal head during childbirth, but this fails to explain the many cases in children and in nulliparae. Simpson considered the cause to be neuromuscular: that the nervous mechanism controlling the detrusor urinae muscle loses its normal balance and exerts too great a force on the loosely attached mucous membrane of the urethra, resulting in its extrusion. This produces partial paralysis of the urethral constrictor

muscle, and the muscular tonus is not regained until the lining membrane is replaced in position by operative or other means

Hepburn (1927) believes the condition in children to be a partial herniation of the bladder and urethra resulting from strain on congenitally weak tissues

Berry and Greene note that prolapse of the urethral mucosa is seen chiefly in patients with patulous urethral meatuses. The urethral mucous membrane is rather loosely attached to the submucous tissues and is fairly redundant in females, and a patulous urethral meatus with a redundant urethral mucosa, they contend, would provide a suitable stage for prolapse of the mucosa suddenly with a great increase of pressure from above, as in coughing or straining at stool or on urination

**Symptoms and Diagnosis** Symptoms vary from slight itching and burning in the vulvar region to severe pain and urinary frequency. Inspection reveals a tumor protruding at the urinary meatus. This may be of considerable size, and is usually dark red in color, congested, and very sensitive to palpation. There may or may not be ulceration and even sloughing of the protruding tissues. The tumor is to be differentiated from other protrusions at the urinary meatus which usually is not difficult

**Treatment** Many methods have been proposed for the treatment of urethral prolapse. When there is only a slight degree of prolapse, the inflammation may sometimes be reduced by rest in bed and wet compresses after which reduction may be attempted either manually or by the cautious employment of a sound. The use of astringents to promote contraction of the tissues may be successful in very mild cases. In rare instances the prolapsed membrane has been digitally replaced and has remained in position without further treatment, but usually fulguration or surgical measures are necessary. These are described under Operative Treatment of Prolapse of the Urethra (p. 783)

#### *Diverticulum (Urethrocele) of the Female Urethra*

Urethral diverticulum or urethrocele, in the female, is a pouch formed by dilatation of a portion of the urethrovaginal septum and communicating with the urethral canal. Many authors use the terms 'urethrocele' and 'diverticulum' interchangeably, others designate as urethroceles pouches that communicate widely with the urethra, and as diverticula pouches with narrow or tubular openings.

Diverticula may be either congenital or acquired but since it is

rarely possible to distinguish between the two types they will be considered together

**Etiology** Diverticula of the female urethra are due to (1) some developmental defect, (2) herniation at a weakened point in the urethral wall due to trauma, or (3) rupture into the urethral canal of a retention cyst of the urethral wall

Trauma incurred in childbirth is the most common cause of weakening of the urethral wall, but intraurethral injury caused by a calculus, catheter, or other foreign body or dilatation resulting from urinary back pressure due to stricture, or an inflammatory process in the periurethral tissues may serve to produce a diverticulum

Such pouches may also be formed by rupture into the urethral canal of a retention cyst of the urethral wall Inflammatory occlusion of a urethral duct may rapidly convert the gland with which it communicates into a retention cyst Subsequent suppuration and rupture result in the cyst again communicating with the urethral lumen, so that the inflammation is chronically relighted and the size of the pouch gradually increased by the pressure and irritation of the partially retained urine Dilatation with urine of one of the glandular structures communicating with a urethral duct may produce a diverticulum Rarely a pouch may form by rupture into the urethra of a retention cyst of the vaginal mucosa

**Symptoms and Diagnosis** Symptoms vary Some diverticula produce no symptoms and are discovered accidentally These are best left alone The most common complaints are of urinary disturbances (dysuria frequency, pyuria) and pain on coitus Secondary infections and stone formation are common, in which event there may be a purulent urethral discharge and hematuria

Palpation through the vagina usually reveals a tender area or a hard or tense tumor on the anterior vaginal wall Pressure on this causes the contents to be expressed into the urethral canal and to appear at the external meatus unless the orifice of the diverticulum is very small or occluded by a stone or calcareous material An instrument passed into the sac through the urethra may be felt through the urethrovaginal septum by the palpating finger

Urethroscopy reveals the abnormal dilatation of the urethral floor or serves to locate the orifice of the pouch Urethrography is a valuable aid in demonstrating the location and size of the sac and the associated pathological changes

Other conditions, from which diverticula must be differentiated are

penurethral abscess, solid tumors, cysts which do not communicate with the urethra, urethral prolapse, and cystocele

**Treatment.** Treatment is total excision of the pouch and plastic restoration of the urethrovaginal septum, after provision has been made for free drainage. The operation is substantially the same as that for diverticulum in the male

### *Urethral Calculus in the Female*

Women suffer from stones in the urethra far less frequently than do men. The brevity and distensibility of the female canal offer little opportunity for the retention of calculi except at the external meatus. Stones occasionally are found in diverticula communicating with the urethral canal.

**Etiology.** Whether diverticular stones tend to form in preexisting sacculations in the urethral wall, or whether these pouches are formed by the stones for their own reception, is a question which has long been debated. Stones may descend into the urethra from the bladder and lodge in the canal or a preformed diverticulum, or may themselves form a pouch in the urethral wall. Primary stones may form in a preëxisting diverticulum by urinary stasis.

**Symptoms.** Dysuria, urinary frequency and urgency, dribbling, and a sense of weight in the perineum are the most common symptoms of urethral stone in the female. Pus and blood can be detected in the urine, and there may be an offensive purousanguineous urethral discharge. Sometimes it is a sudden attack of complete retention that causes the patient to seek medical advice, indicating that the stone has shifted its position and is completely occluding the urethra. A bladder stone descending into the urethra may cause similar obstruction. A calculus impacted in the sphincter may make evacuation of the bladder impossible and produce acute symptoms which are always terrifying to the patient. More often, however, a stone lodged at the sphincter will cause patency of that structure, with complete incontinence.

A stone or multiple stones lodged in a diverticulum in the anterior urethra will cause protrusion of the pouch from the urethral floor, interfering with or preventing coitus.

**Diagnosis.** Diagnosis is not difficult. The stone or stone filled pouch can usually be palpated through the vagina. The diagnosis is confirmed by instrumentation and urethrography.



**Treatment.** Treatment consists in removal of the concretions by the most accessible route. The method selected depends upon the number, size, and location of the stones. Occasionally it may be possible to dilate the urethra sufficiently to permit withdrawal of the stone by the natural route. Single concretions can sometimes be coaxed out by patient manipulation following the injection of oil, as in ureteral stone.

If the stones are packed into a diverticulum, an incision is usually made in the vaginal wall and the sac and its contents removed through this (Excision of Diverticulum, p. 691), or the calculous contents may be removed through the vaginal incision and the diverticulum treated by diathermy. Mere removal of ensacculated calculi, without extirpation of the sac, cannot be relied upon for permanent relief inasmuch as more concretions are likely to form so long as the sac remains. A stone impacted near the sphincter is best removed through an incision in the vaginal wall or by suprapubic cystostomy.

A calculus may sometimes be removed through the urethroscope, following which its lodging-place should be treated by diathermy.

### *Urethral Lesions in Female Children*

Young females are seldom the subjects of urethral pathology. Although numerous articles and even monographs devoted to urological conditions in children have appeared in recent years, they are all conspicuously silent regarding urethral lesions in female children.

*Congenital "valves," strictures, and anomalous ureteral orifices in the urethra* are occasionally seen. These have been discussed under Anomalies. *Epispadias* (p. 579) is even rarer in female children than in boys. *Prolapse of the female urethra* is more common in little girls than at any other period of life, and a few cases of *urethral calculus* have been reported. These conditions are treated in the same manner as when they occur in adults.

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## CHAPTER XXVI

### OPERATIVE TREATMENT OF THE FEMALE URETHRA

Much that pertains to operative treatment of the urethra in the female has already been discussed in the preceding chapter. The only procedures that need be considered here are (1) excision of Skene's glands and (2) operations for prolapse of the urethra.

The operative treatment of hypospadias and epispadias is described in the chapter on Operative Treatment of the Female External Genitalia (p 603). Operations for the relief of urinary incontinence are considered under Surgery for Incontinence of Urine (p 1137).

#### *Preoperative Preparation*

Methenamine, or other urinary antiseptic, may be administered orally for several days before operation. The urethral canal should be irrigated with a mild antiseptic solution, such as normal saline solution, boric acid, 4 per cent, argyrol, 2 per cent, or potassium permanganate, 1 4,000.

The external genitalia and pubis are shaved, cleansed with tincture of green soap and warm water, and sterilized by spraying with tincture of zephiran, 1 1,000 or tincture of merthiolate, 1 1,000, or other preferred skin sterilizing solution.

For intraurethral procedures, the preparation is the same as for cystoscopy or urethroscopy.

#### *Anesthesia*

Most operations upon the female urethra are now done under spinal or sacral anesthesia. For meatotomy and operations within the urethra, local anesthesia with cocaine derivatives is usually satisfactory. For young children, general anesthesia is generally preferable. See Anesthesia in Urology (Chapter VI).

#### *Diversion of the Urinary Stream*

If the intervention upon the urethra is an extensive one, it is always safer to do a suprapubic cystostomy, so that the urine will be diverted from the wounded area until complete healing has had time to ensue.

*Operative Treatment of Skene's Glands*

**Skene's Method** Skene's original method of dealing with inflammation and abscess of the glands which bear his name is still in accredited use. It consists in inserting a probe into the gland bearing down upon

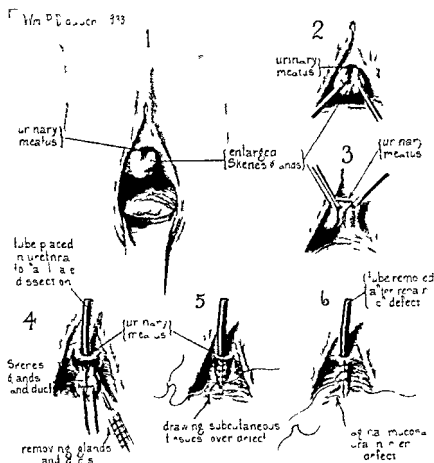


FIG. 153. Operation for removal of infected Skene's glands. (1 2 3) Showing the enlarged Skene's glands and the urinary meatus. (4) A tube is placed in the urethra to facilitate dissection and the glands are exposed by an incision curving around the posterior surface of the urethra. With traction on the ducts the enlarged glands and ducts are dissected free and excised. (5 6) The incision is closed over the urethral tube which is then removed.

this until the urethrovaginal septum is held tense and then applying the actual cautery or one of the high frequency current devices.

**Excision of Skene's Glands** This procedure is so well illustrated in figure 155 that little description is required. The anesthetized patient

is placed in the lithotomy position. The labia are retracted, exposing the field and a tube placed in the urethra to facilitate dissection. Skene's glands and ducts are then exposed by an incision curving around the posterior surface of the urethra. With traction on the ducts, the enlarged or abscessed glands are dissected free from their bed outside the urinary meatus and excised. The incision is closed over the urethral tube with interrupted catgut sutures, as illustrated in figure 155 (5, 6), and the tube withdrawn.

### *Operative Treatment of Prolapse of the Urethra*

**Fulguration** In many cases of urethral prolapse, particularly in little girls, removal of the prolapsed mucosa with the fulgurating current has proved very satisfactory. Berry and Greene (1938) successfully used the fulgurating current in a particularly severe case to remove the prolapsed, strangulated and almost gangrenous mucosa, and believe fulguration to be the simplest and best method of treating this condition.

Fulguration is followed by the use of an indwelling catheter for 2 or 3 days, and later by occasional dilatation of the urethra.

**Operative Procedures** Many operative procedures have been proposed for urethral prolapse:

(1) A catheter may be introduced into the urethral canal, the prolapsed mucosa excised or removed with the fulgurating current, and the cut edges united by suturing all around the orifice.

(2) Shortening of the constrictor muscles may be carried out if digital replacement of the prolapsed mucosa is possible. A vertical incision is made through the mucous membrane, muscle fibers and connective tissue at the lower end of the meatus, and the ends of the circular muscle fibers on each side picked up with tenacula. A probe is then passed into the bladder and the muscle ends united tightly about the probe by chromic catgut sutures.

(3) Through a suprapubic incision, Hepburn reduces the prolapse and then anchors the anterior bladder wall to the periosteum of the pubic bone and to the anterior abdominal wall.

(4) Emmet's classic 'buttonhole' method has been compared by its originator to "the drawing of a portion of a handkerchief through a buttonhole in a coat." A sound is placed in the urethra and an incision made in the anterior wall of the vagina over the median section of the urethra, as far down as the redundant portion of the mucous membrane. The prolapsed portion of mucous membrane is then drawn through the slit, traction being directed from before backward. While an assistant

is holding up the excess of tissue, a large sized sound is introduced, smoothing out the lining membrane and carrying it toward the vesical neck. This places the canal somewhat on the stretch. With the sound in place, the sutures are introduced, the needle passing entirely through the flaps into the urethra, so as to transfix the lining membrane along the edges of the wound. The redundant tissue is then removed and the incision closed.

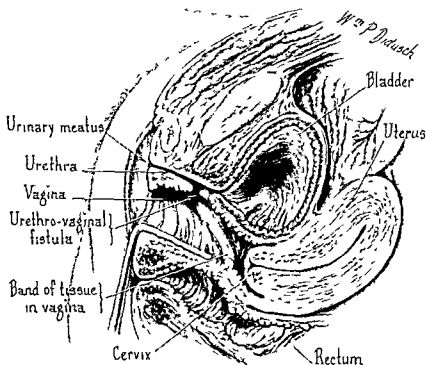


FIG 156 Urethrovaginal fistula operation for its repair. The patient in this case had a precipitate delivery. During childbirth, the hypertrophied annular band of fibrous tissue noted in the drawing was ruptured on the roof of the vagina. It was firmly attached at this point to the urethra, and during its rupture a hole was torn into the floor of the urethra. The sagittal section above shows the orifice of the fistula and the fistulous tract connecting the urethra with the vagina. There was no incontinence of bladder urine, but during urination all the urine passed through the fistulous tract into the vagina. (Case of Dr Roy B Henline and Dr James P Hennessy.)

#### *Operative Repair of Urethrovaginal Fistula*

Urethrovaginal fistulas are usually the result of trauma incurred during a difficult labor. The condition and an operation for its repair are illustrated in figures 156 and 157.



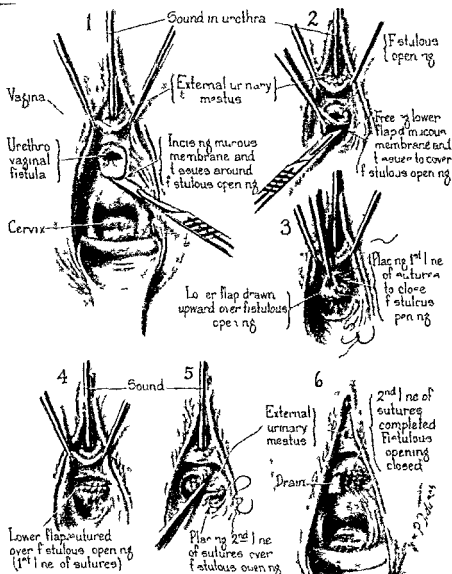


FIG. 157 Urethrovaginal fistula (1) Incising the mucous membrane and tissues around the fistulous orifice (2) Freeing the lower flap of mucous membrane and tissues to cover the fistulous opening The vaginal mucous membrane forms the floor of the urethra (3) Drawing the lower flap upward over the fistulous opening (4 and 5) Placing the sutures over the fistulous opening Closure completed drain placed When this patient was last seen more than 2 years after operation the fistula was well healed and urination normal (Case of Dr. Henline and Dr. Hennessy)

### Postoperative Considerations Following Operations on the Female Urethra

If the operation has been properly performed, under strict aseptic precautions, the postoperative course is seldom eventful Hemorrhage

is uncommon, but it should be remembered that the bladder neck is extremely vascular, and when large, jagged calculi are removed from this area the danger of severe hemorrhage is always present.

The urinary function must be closely watched. Any operation upon the urinary or genital tract in the female is almost certain to produce complete anuria for a brief period, and, anticipating this, there may be failure to observe signs which indicate that something more than the ordinary postoperative retention is complicating the patient's recovery.

Particularly to be guarded against, following operation upon the female urethra, are urethrovaginal fistula and stricture of the area operated upon. Diverting the urinary stream from the operative site by a suprapubic cystostomy is always safer in extensive interventions, thereby relieving the wound from the pressure and irritation of the urine—the most common cause of necrosis of a urethral repair. In the female, as in the male, it is most important to dilate at regular intervals, and for some time every urethra that has been operated upon for any cause whatsoever, in order to overcome any tendency to contraction and stricture formation.

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## CHAPTER XXVII

### EMBRYOLOGY, ANATOMY, ANOMALIES, AND PHYSIOLOGY OF THE PROSTATE GLAND

The prostate gland is the most important of the male accessory reproductive glands, both from a physiological and a clinical viewpoint. It is a musculoglandular organ, lying at the neck of the bladder and enclosing within its structure the prostatic portion of the urethra and the ejaculatory ducts.

#### A EMBRYOLOGY OF THE PROSTATE GLAND

**Development of the Tubules and Musculature** The development of the prostate gland begins at about the twelfth week of fetal life. Lowry's detailed studies showed that at this time solid epithelial evaginations, from five distinct parts of the embryonic deep urethra, make their appearance. These epithelial buds are composed of cells which stain deeply and early assume a circular arrangement, later forming lumina and branches and producing the tubules which constitute the nucleus of the prostate. Fibromuscular stroma develops about these tubules and becomes denser at the periphery to form the prostatic capsule.

Five distinct groups of tubules thus arise from the five points of origin, which are located as follows: on the floor of the urethra between the bladder neck and the orifices of the ejaculatory ducts and the utricle, one on each side of the urethra in the prostatic furrow, on the floor of the urethra just below the orifices of the ejaculatory ducts and the utricle, and on the ventral, or anterior, wall of the deep (prostatic) urethra.

From these five groups of tubules and their surrounding stroma there eventually develop five lobes, namely the middle, right and left lateral, posterior, and anterior lobes. Early in fetal life there is wide separation of the middle and the two lateral lobes, but in its later stages the distance between them is greatly diminished.

In specimens of prostates removed from the newborn no actual intermingling of the tubules was observable, but the tubules of the middle and lateral lobes were seen to lie side by side, with no definite capsule separating them. The posterior lobe, however, was entirely distinct, a dense

layer of fibrous tissue separating it from the lateral lobes. The anterior lobe was also set apart some distance from the lateral lobes.

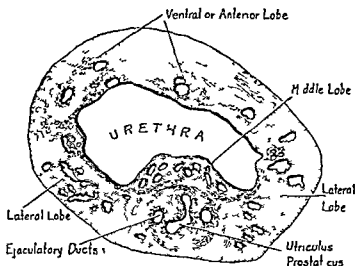


FIG. 158. Cross section through the prostate, seminal vesicle and ejaculatory duct of an embryo  $3\frac{1}{2}$  months old. This specimen shows solid epithelial outgrowths of the tubule groups forming the ventral, lateral and middle lobes. These later develop lumina. The posterior lobe tubules do not appear in this section. They occur lower down or outward and communicate with the urethra below the entrance of the ejaculatory ducts. An evagination from the left ejaculatory duct shows the beginning of the seminal vesicle.

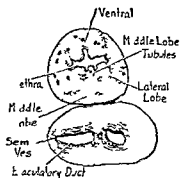


FIG. 159. Cross section through the prostate of an embryo aged  $5\frac{1}{2}$  months. The tubules have developed lumina and show branches. The ducts of the middle lobe tubules are grouped in a separate envelop on the top of the verumontanum which is formed by the ingrowth of the ejaculatory ducts with the utricle prostaticus.

Muscular fibers surrounding the prostatic tubules may be observed in an embryo of 16 weeks. By the twenty second week these are considerably developed especially at a point where certain of the lateral lobe tubules extend away from the base of the prostate. The muscular



FIG 160 Sagittal view of a wax model of the prostate of a newborn male infant. The prostatic tubules are represented with the branches grouped. U urethra widening out above into the bladder. A L anterior lobe tubules which have shrunk to insignificance. U P, utriculus prostaticus. A G subcercal group tubules. M L middle-lobe tubules which occur between the urethra and the E J ejaculatory duct. S V the seminal vesicle. Lat lateral lobe tubules some of which project forward into a position anterior to the urethra. P L posterior lobe tubules occurring behind the ejaculatory ducts. In the lower left hand corner is a diagram representing the position of this particular prostate in relation to the bladder.

ture thickens progressively, until, at birth, some of the tubules are surrounded by dense layers of fibromuscular tissue

*The Middle Lobe* Rarely, there is absence of the middle lobe tubules, but in most instances the middle lobe develops independently from the group of tubules originating from the floor of the urethra near the median line between the bladder neck and the orifices of the ejaculatory ducts and the utricle. In young embryos, the middle lobe tubules are separated from those of the lateral lobes by a considerable area of tissue containing no glandular elements. As the embryo develops, however, this intervening area decreases, and in the later fetal stages although the tubules and their branches maintain their characteristic positions, there is no longer a distinguishable fibrous capsule separating the middle from the lateral lobes.

As the structures of the verumontanum develop the largest of the middle lobe tubules, which originally lay near the middle line, are pushed upward so that eventually they open high up on the sides of the verumontanum, their original position in the middle line being occupied by the orifices of the ejaculatory ducts and utricle. If independent middle lobe tubules are entirely lacking (which Lowsley observed once in 103 specimens examined), branches from the lateral lobes will approach the median line in the region ordinarily occupied by the middle lobe.

In most cases the middle lobe is made up of some 9 or 10 large tubules.

*The Lateral Lobes* The lateral lobes are composed of tubules both larger and more numerous than those of the other lobes. They originate from the right and left prostatic furrows and the lower parts of the lateral walls of the urethra and, by backward and outward extension, form the main part of the prostate's base. In early specimens these two lobes are widely separated from each other and the other lobes, but, with growth the distance between the tubules of the lateral and middle lobes progressively lessens except at the point where the ducts communicate with the urethra, where the distinction always remains perceptible.

The tubules always grow backward toward the bladder except in the apical region where a few of the lateral lobe tubules send branches in a forward direction.

In a specimen from a newborn infant, the lateral lobes displayed two widely branching tubules which extended up into the anterior commissure, where they formed practically a glandular commissure. Usually a considerable area of stroma, containing anterior lobe tubules, lies be-

tween the anterior portions of the lateral lobes. Mesially, the ejaculatory ducts, urethra, and middle lobe of the prostate are interposed, a definite plane of connective tissue separating the posterior branches of the lateral lobes from the posterior lobe.

In specimens examined, the tubules forming the two lateral lobes varied in number from 27 to 46, averaging about 37.

*The Posterior Lobe* The posterior lobe is an independent structure, developing from tubules which are distinct from those of the other lobes and separated from them by a definite capsule that is only connected laterally with the capsule of the gland proper. These tubules begin to develop, with those of the other lobes, in the third month of intrauterine life. They are found in the urethral floor below the openings of the ejaculatory ducts and the utricle, and their direction of growth is behind these structures backward toward the bladder. The posterior lobe tubules compose the major portion of the prostate's apex, that section of the gland which is palpable through the rectum. While relatively large and extensively branching, they are few in number, averaging only about eight. Although no evidence of such stroma is perceptible in the early months of fetal development, later the posterior lobe is separated from the ejaculatory ducts and the posterior branches of the lateral lobe tubules by a layer of connective tissue devoid of tubules.

Benign hypertrophy rarely takes place in the posterior lobe, but primary carcinoma is more likely to originate here than elsewhere in the gland. This coupled with the fact that its tubules are entirely independent of the other prostatic tubules and in the fully developed male, much larger, suggests that this lobe may have a function distinct from that of the remainder of the gland.

*The Anterior, or Ventral, Lobe* The anterior lobe is formed from tubules originating from the anterior wall of the prostatic urethra. At first large and multi-branched, these tubules gradually decrease both in size and number. By the twenty-second week they appear to have lost most of their branches, and thereafter the anterior lobe becomes increasingly insignificant until, at birth, only two small tubules are in evidence. Occasionally, however, the anterior lobe persists into adult life. Among 593 adult prostates examined by Lowsley there were found 10 with hypertrophied anterior lobes, one of which showed carcinomatous degeneration. Kuznitsky reports finding a persistent ventral lobe in 1 out of every 15 adult prostates examined by him.

The average number of anterior lobe tubules in the fetal specimens

examined was 13 for the first half of the intrauterine period and 6 for the second half

**Prostatic-duct Openings into the Urethra** In most text books the number of the ducts from the various lobes which open upon the floor of the urethra is given as from 20 to 30. It has been Lowsley's observation that this estimate is far below the actual average. In none of the specimens which he examined were there fewer than 53, 2 specimens showed as many as 74, and the average for the 6 specimens studied—including one in which the middle lobe was absent—was 63.

**Subsidiary Prostatic Glands** Two other groups of small, poorly developed subsidiary prostatic glands are of interest to the urologist: (1) the *subcervical* (Albarran), which lie beneath the bladder neck and begin to develop in the fourth month of fetal life, increasing slightly in size and number until birth; (2) the *subtrigonal* (Home), which lie beneath the mucosa of the trigone. Because of their position, even slight enlargement of either group produces urinary obstruction.

## B ANATOMY OF THE PROSTATE GLAND

**Location and Shape** The prostate gland lies at the neck of the bladder in front of the lower portion of the rectum, through which it may be distinctly felt. It is pierced by the urethra and the ejaculatory ducts. In shape, it resembles a somewhat flattened cone, with its base closely apposed to the bladder neck and its apex directed downward and in contact with the triangular ligament.

The posterior surface, which faces the anterior surface of the rectum, is triangular and flattened. Extending longitudinally in the midline there is usually a shallow groove, which is most prominent toward the base and rarely, if ever, existent at the apical third. The upper border receives the ejaculatory ducts in an elliptical funnel shaped depression.

The anterior surface faces the symphysis pubis from which it is separated by cellular connective tissue and the prostatic plexus of veins.

The lateral surfaces are rounded and prominent and are closely related to the anterior portions of the levator ani muscles. In specimens obtained before puberty there is far less lateral bulging, but the general contour is about the same.

The prostate is enclosed in a firm fibrous capsule, known as the *true prostatic capsule* and is rather firmly fixed in position by heavy fascial investments.

**Structure** The prostate is a musculoglandular organ of the compound tubular type.



*The glandular portion* consists of two distinct types of secreting tubules (1) external, or prostatic glands proper, which make up the major portion of the gland, and (2) internal, or periurethral, glands. The prostatic glands proper consist of units of follicle like tubules, each equipped with its excretory duct which opens into the prostatic urethra. These glandular units begin to branch about a centimeter from their orifices and, after giving off several subdivisions, end in alveoli. The alveoli are lined by the usual simple columnar epithelial cells, their inner portions often showing acidophile granules. A pseudostratified epithelium with two rows of nuclei, occasionally is present. The basement membrane consists of delicate connective tissue threads. The ducts are supplied with a mucous membrane composed of simple columnar cells except at their orifices, where they are replaced by transitional epithelium similar to that of the posterior urethra. The periurethral, or inner, units of tubules consist of (1) small, mucosal tubules located in the roof of the urethra over the verumontanum, and (2) longer, branching submucosal glands, whose ducts open into the prostatic urethra alongside those of the prostatic glands proper. The periurethral units of tubules are of great clinical importance because it appears that prostatic hyperplasia arises from them and not from the prostatic glands proper.

*The musculo-connective tissue portion* of the prostate is composed of smooth muscle cells and many elastic tissue fibers. Within the gland is a dense fibromuscular mass, which surrounds the urethra and sends out muscle bands of transverse and longitudinal fibers that spread in all directions, usually following the connective tissue stroma but sometimes themselves constituting the interalveolar septa no admixture of fibrous tissue being discernible. Smooth muscle fibers surround each tubule and its duct to the urethral opening those encircling the ducts being connected with the circular muscle coat of the urethra. These muscle fibers, by their contractions serve to empty the tubules and ducts of their secretory products.

The sheath and muscular stroma of the prostate are intimately connected with both the internal (vesical) sphincter and the external (urethral) sphincter, but the innervation of the musculature of the prostatic tubules is entirely independent of that of the sphincters, and is for the sole purpose of expressing the prostatic secretion into the urethra. The prostate remains passive during urination, which is a function of the neuromuscular system of the bladder and urethra.

**The Prostatic Capsule** The five lobes of the prostate are enclosed in

a common capsule, which is so closely united with its surrounding fascia that, in most instances, it would be impossible to differentiate the two were it not that the latter contains the venous plexus and by using this for a guide, the fascia can usually be separated from the capsule proper. When they have been dissected apart, the capsule emerges as a thin but firm membrane, composed of involuntary muscle and fibrous tissue covering the entire prostate and sending prolongations into the parenchyma of the gland, separating the outer portion of the lobes. So firm is its attachment to the gland that any attempt to strip off the capsule carries away part of the underlying glandular tissue.

**Size** Careful measurement by Lowsley of 224 specimens obtained from routine autopsies showed that in every instance the width of the prostate gland is greater and its thickness less than the antero-posterior diameter. There is always greater prominence of the lateral portions than of the middle part of the base, so that in adult prostates the distance from the apex to the lateral prominences exceeds that from the apex to the middle of the base by 0.2 to 0.5 cm.

Specimens of the first decade were obtained for the most part from subjects less than 5 years of age. As there is only a very gradual growth of the gland during these first 5 years the prostate of a child at this age is surprisingly little larger than that of the newborn. The average length during the first 5 years is 1.2 cm, the width 1.5 cm, and the thickness 0.9 cm.

As is to be expected, there is a great increase in the size of the prostate after the twelfth year. Indeed the increase in this organ is proportionately greater than that observed in other organs of the body during the same period. The enlargement apparently affects to the same degree all the lobes except the anterior, and there is a corresponding increase in the interlobular and intralobular connective tissue. The muscular tissue surrounding the tubular elements becomes greatly thickened although in the mucosa there is no very marked change. One specimen removed from the body of a 17-year-old boy, measured 2.28 cm in length, 3.9 cm in width, and 1.8 cm in thickness indicating a nearly 100 per cent increase in the dimensions of the prostate during the period of puberty. In general, the increase in size during the second decade is marked. The average dimensions of the prostate in 10 specimens from subjects between 15 and 20 years of age were length 3.0 cm (which is more than twice that of the average prostate during the first decade), width 3.8 cm, and thickness 2.1 cm.

The prostate gland reaches adult size during the third decade, but few changes—and these comparatively slight—occurring after that period. The average length Lowsley found to be 3.3 cm., width 4.1 cm., and thickness 2.4 cm.

There is a slight increase in all the dimensions during the fifth and sixth decades, but this amounts to only a few millimeters. In old age there is a noticeable decrease in size, so that specimens taken in the senile period usually resemble those of the third decade more than those of any other period. Examination of specimens from this period shows them to be either a little smaller and more atrophic in appearance than those of the period preceding, or a little larger and displaying hypertrophic characteristics. Prostate glands obtained from elderly and aged subjects show more abnormalities than those of other age periods. In Lowsley's series, 56.1 per cent showed some deviation from the normal, and about one third of all specimens obtained from men over 60 years of age showed more or less adenomatous hypertrophy.

**Weight.** Careful observers differ regarding the average weight of the adult prostate. Wilson and McGrath place this at 16 to 17 Gm., Cuthbert Wallace at 20.5 Gm., Piersolat 22 Gm., Sir Henry Thompson at 18.5 gm., and Teem at 20.7 Gm.

**The Fascial Investments of the Prostate.** The prostate is encircled by a sheath called the *prostatic fascia*, which lies just outside the true prostatic capsule and is derived from the rectovesical fascia. This structure springs from the linea alba, passes over the internal surface of the levator ani muscle, and finally divides into three layers: an upper, or anterior, layer, adherent to the prostate and the pubis, which passes over the gland's anterior surface and above its venous plexus; a median layer, which passes behind the posterior surface of the prostate and under its lateral venous plexus; and a lower, or posterior, layer, immediately adjacent to the anterior wall of the rectum. It is the median and posterior layers that constitute the aponeurosis of Denonvilliers, which covers the posterior surface of the prostate and the seminal vesicles. Within the prostatic fascia are located the vessels of the gland.

*Denonvilliers' fascia* is a rather light colored fibrous plane of fascia which is sometimes so thick and firm as to be almost leathery in consistency. This structure, which was originally described by Denonvilliers (1836) as the "prostatoperineal aponeurosis" separating the prostate and seminal vesicles from the rectum, constitutes an important surgical landmark in perineal operations. The glistening anterior layer of De

nonvilliers' fascia is applied to the posterior layer of the prostate, and its posterior layer to the rectum

This fascia always extends downward to the apex of the prostate, covering its entire posterior surface. At the apex the fascia is lost in the fibrous structures of the perineum around the membranous urethra and the triangular ligament. In the distribution of its upper border it may vary considerably. Ordinarily it is semilunar in outline, the lowest point of the concavity being just above the place where the vasa deferentia approach each other and become bound together in a common envelop. Laterally the fascia projects into a horn like process on each side, which covers the posterior surface of the seminal vesicles and merges, just above the upper end of each vesicle, with the connective tissue about the seminal vesicles and vasa. This firm barrier between the posterior surfaces of the prostate and seminal vesicles and the rectum is an important factor in the prevention of the extension of disease particularly malignancy, from the urogenital tract to the rectum.

Denonvilliers' fascia adheres with moderate firmness to the posterior surface of the vesicles and prostate everywhere except at the upper border of the posterior lobe of the prostate. Here it is so intimately attached that it can be dissected free only with the greatest difficulty. One leaflet extends between the prostate and the seminal vesicles and is tightly joined to the prostatic capsule.

Except for the upper border, the fascia is a sharply defined structure throughout. In specimens where the upper border is not of semilunar outline it often extends farther upward, even directly across from the upper end of one seminal vesicle to the other, so that the marginal outline is much less concave.

The blood supply is limited practically all the small vessels which may be seen coursing through the tissue being confined to the anterior layer, or that portion in contact with the prostate and vesicles.

**Blood Vessels of the Prostate** *The Arteries* The arteries of the prostate are considered in some detail because of their surgical importance. The main source of the arterial supply is the genitovesical artery derived from the anterior branch of the hypogastric artery. The internal pudendal and middle hemorrhoidal arteries each send a few insignificant branches to the lower portion of the gland. The genitovesical artery passes medially over the surface of the levator ani muscle to the bladder base where it sends branches to the bladder (inferior vesical artery) and the prostate (prostatic artery), with which it comes in contact at the postero superior aspect on each side.

In a very careful study of the arterial distribution of 43 prostates (both normal and pathological), R H Flocks (1937) demonstrated that the prostatic artery gives rise to two groups of arteries which distribute themselves in a fairly regular manner throughout the prostate (1) the *urethral, or inner, group* and (2) the *capsular, or outer, group*. The so called urethral group penetrates the tissues at the prostatovesical junction and supplies the vesical neck and the inner, or urethral, portion of the prostate except in the region immediately about the verumontanum. These vessels are of large caliber and anastomose very freely about the circumference of the urethra. The capsular group courses along the postero-lateral surface of the gland and sends branches dorsally and ventrally in a radial manner to supply the outer portion of the gland, approximately two thirds of the total glandular tissue. These branches anastomose to a moderate extent with branches of the urethral group. The branches of the capsular plexus penetrate deeply in the most distal part of the prostate to supply the prostatic tissue adjacent to the verumontanum.

Flocks found that the urethral group of arteries enlarges moderately from infancy to adulthood and very markedly with the occurrence of hyperplasia. The external capsular group, on the other hand, shows little change with age or with hyperplasia.

The earlier investigations of Adrien (1922), Bumpus and Antopol (1934), and E Kraas (1935) resulted in essentially similar conclusions regarding the separate sources of the arterial supply of the inner and outer portions of the prostate.

*The Veins* Some of the veins from within the glandular tissue and around the ducts, on emerging from the sides of the prostate, are grouped in a series of large channels in the lateral ligaments, where they form the vesical plexus. The remainder reach the prostatic plexus (of Santorini), a rich venous plexus lying between the anterior surface of the prostate and the symphysis pubis and receiving not only the blood from the prostate but also that from the deep dorsal vein of the penis. This plexus communicates freely with the vesical and hemorrhoidal plexuses and eventually empties into the hypogastric veins.

*The Lymphatics* The lymphatics of the prostate arise in networks surrounding the alveoli and unite to form larger vessels which communicate with a wide meshed network on the surface of the gland. There are four lymphatic trunks: a superior and a lateral on each side of the prostate. These terminate in the iliac and sacral lymph nodes.

**The Nerves** The innervation of the prostate is derived from the hypogastric plexus of the sympathetic and from the anterior roots of the third and fourth sacral nerves. In their branches are to be observed both medullated and non medullated fibers and ganglion cells of relatively large size. The course of the nerves is along the arteries, from the levator ani muscles to the postero lateral surface of the gland, whence the prostate and seminal vesicles are innervated and the plexus is eventually distributed to the erectile tissue of the penis. In the prostate the nerves ramify and terminate in muscles and the epithelium of the tubules.

Clinically, it has long been recognized that pathological conditions of the prostate are accompanied by severe nervous disturbances, the most common being the referred pains which occur in the small of the back, in or about the rectum, and down the legs. Timofeev, in his very complete study, has described a complicated system of nerve fibers and endings which assists greatly in understanding this feature of the anatomy of the prostate. Von Planer gave an account of numerous nerve endings situated in the superficial layer of the mucous membrane of the prostatic urethra and Timofeev tells of a wide mouthed plexus of medullated fibers within the deeper layers of the capsule. Fine non medullated fibers pass through the prostate from the plexus, and, branching freely, end between the epithelial cells. Other branches form tuft like end bodies and still others encapsulated end organs.

Besides the sensory fibers Timofeev mentions the existence of many others, which are apparently secretory as they resemble similar fibers in other glandular structures. He also describes both motor and sensory end structures on the striated fibers of Henle's muscle. They are at first medullated, but terminate as non medullated fibers. The nerves of the smooth muscle fibers are non medullated, forming between the muscular layer thick plexuses of varicose fibrillae which send out numerous branches.

**Contiguous Structures** *Ejaculatory Ducts and Prostatic Urethra* The ejaculatory ducts run from above downward and forward through the substance of the prostate. They pierce the posterior wall of the prostatic urethra on both sides of the utricle and, with the utricle compose the longitudinal prominence on the posterior wall of the urethra known as the verumontanum (p. 611). The orifices of the ejaculatory ducts lie on the right and left borders of the verumontanum and serve to divide the prostatic urethra into a proximal and a distal section.

In the furrows on each side of the verumontanum open the ducts of the lateral lobes of the prostate, while the ducts of the middle lobe open proximal to the verumontanum upon the posterior wall of the urethra. The ducts of the posterior lobe tubules open distal to the ejaculatory-duct orifices. When ducts from the anterior lobe are present, they will be found to open upon the ventral, or anterior, wall of the urethra.

As Wilson and McGrath have pointed out, the common custom of considering the subdivisions of the prostate according to its external form alone ignores the organic divisions, that is, the zones of glandular distribution. An exact comprehension of the glandula prostatica could only be acquired by freeing the gland, with its lobes and lobules, from the surrounding musculature. Thus defined, these glandular lobes present agglomerations of lobules of each individual group by the fact that their excretory ducts open in common at a definite place in the urethra, and are to be designated prostatic lobes in the strict sense. Following this principle of classification, the glandula prostatica, more or less independently of its outer form, consists of two symmetrical lateral lobes, an interposed middle lobe, a small anterior lobe, and the posterior lobe.

*Subsidiary Prostatic Glands* There are two groups of rudimentary subsidiary glands which are of considerable clinical importance (1) the *subcervical group* and (2) the *subtrigonal group*. The majority of benign enlargements of the prostate arise in these two groups of tubules and in the inner, or periurethral, portion of the prostate gland.

*The subcervical (Albarran's) tubules* appear to be of independent origin and to have no functional relation to the prostate. They lie within the vesical sphincter, between the vesical orifice and the upper end of the verumontanum. There are 30 or more branched tubules, the ducts of which open proximal to the verumontanum in the middle of the urethral floor. Most of the subcervical tubules lie in the mucous membrane inside the vesical sphincter, although a few may penetrate to the submucosa. These tubules are of less complicated structure than those of the prostate gland proper, and are lacking a definite muscular and connective tissue stroma. In some specimens the prevailing cell of the mucosa of the subcervical group is cuboidal. The subcervical tubules begin to develop in the fourth month of fetal life and increase slightly in size and number until birth. This increase is continued during the period of youth and enormously accentuated after puberty.

The subcervical tubules are of great interest to the urologist, for their location subjects them to many influences tending to produce pathology.

cal changes A study by Lowsley of more than 550 prostates collected from routine necropsies showed enlargement of the subcervical tubules in about 25 per cent of the subjects over 30 years of age In practically all cases of prostatic hypertrophy there was a considerable degree of accompanying enlargement in these subsidiary glands This enlargement is apparently stimulated by the same factors which influence prostatic hypertrophy indeed it appears that Albarran's glands respond to this stimulation even earlier than does the prostate proper

*The subtrigonal (Homes) tubules* are found in the mucosa of the trigonum vesicae usually below the center and occasionally as far anterior as the apex of the prostate These reach and at times penetrate the submucosa The tubules are generally simple those from younger specimens being devoid of branches while those from middle aged subjects have one or two branches Their histological structure is not distinctive the lining being of transitional epithelium similar to that of the bladder with cells piled up five or six deep in some cases The lumina are usually quite small

The surgical and clinical importance of these tiny structures is twofold (1) Their position is such that any enlargement may impede evacuation of the bladder (2) enlargement occurs often enough to merit consideration of its possibility in the diagnosis of any pathological condition involving the vesical neck Cases have been observed in which there was enlargement of these tubules and further growth caused them to become almost free in the vesical cavity connected with their original site by only a small pedicle When urination was attempted this globular mass fell into the vesical orifice blocking it more completely than if an enormous adenomatous prostate were present

### C ANOMALIES OF THE PROSTATE GLAND

Malformation of the prostate gland unassociated with other developmental errors is very rare

Defective formation or arrested development of the prostate is usually seen in association with cryptorchidism and consequent defective development of one or both testicles or with exstrophy of the bladder with complete epispadias There have been reported several instances of monorchidism with non-development of the prostate and seminal vesicle on the side of the missing testicle the prostatic lobe and seminal vesicle on the opposite side being normal

Occasionally in endocrine deficiency there may be complete absence of the prostate In an extensive study of endocrine deficiency in con



junction with retarded and imperfect genital development, Lissner (1923) cites 13 cases where no prostate could be palpated. All of these patients had other genital abnormalities and several were mentally deficient as well.

#### D. PHYSIOLOGY OF THE PROSTATE GLAND

The earlier conception of the prostate as an essential part of the urinary apparatus and only secondarily concerned in the genital function has given way to a recognition of its importance in the male genital complex and its non participation in the function of urination. The evidence classing it as a sexual instead of a urinary organ has been thus summed up by C. W. Wallace: (1) It is confined to the male sex, (2) it enlarges rapidly at puberty along with the other sexual organs, (3) it exhibits seasonal activity in animals such as the mole and hedgehog which mate only at certain seasons of the year, (4) it fails to grow in persons castrated in youth, (5) it atrophies in men castrated in adult life. As removal of the prostate gland does not necessarily render a man incapable of reproduction it is evident that it is of only secondary importance.

**Secretory Function of the Prostate** The only proved function of the prostate gland is the production of an external secretion which together with the secretions of the seminal vesicles, Cowper's glands and the mucous glands of the urethra mixes with the testicular secretion at the time of ejaculation to form the seminal fluid. The relation of these various secretions of the accessory sex glands to each other is poorly understood but their outpourings are practically simultaneous (Ejaculation, p. 527). The prostatic fluid supposedly dilutes the testicular and seminal vesicular secretions and separates and activates the spermatozoa. It supposedly also coagulates the secretion of the seminal vesicles.

The formation of an internal secretion by the prostate has not been proved.

The prostate does not become an active gland of secretion until puberty, this activity being coincident with the formation of spermatozoa in the testicles. The sexual activity of the gland continues to increase until after the twenty-fifth year but by the thirtieth year this power is apparently stationary and shortly thereafter begins to decline. After the fortieth year the fibromuscular stroma thickens which may be regarded as the first harbinger of senility.

The prostate is the most important of the accessory sexual glands. Its intimate relation to the testes is well shown in the marked glandular

atrophy following castration, or, if performed before puberty, in the arrested development of the prostate. The interrelationship between the testis, the prostate and other accessory sex glands, and the hypophysis is considered at greater length under Physiology of the Testicle (p. 390) and Etiology of Prostatic Hypertrophy (p. 826).

**The Prostatic Secretion.** Normal prostatic secretion is thin, slightly viscid, opalescent, of an alkaline or neutral reaction (never acid in the pure state), and gives off a characteristic odor. As it contains but 2 or 3 per cent of solids, its specific gravity is less than that of urine, of which the solids make up about 5 per cent.

The chief solid constituent is sodium chloride (0.5 to 1 per cent). There are traces of potassium and magnesium chloride and a slightly larger amount of calcium chloride, together with calcium and magnesium sulphate. Albumin, in the form of nucleoproteids, fibrinogen, and mucinoid substances, compose from 0.35 to 0.75 per cent of the solids.

The milky appearance of the prostatic fluid is due to the presence of minute, translucent, moderately refractile lecithin bodies. The lecithin globules are usually embedded in the amyloid constituents of the secretion. Corpora amylacea are regularly found on examination of the fluid. Their occurrence has been attributed to coagulation of the albuminous glandular contents together with cellular disintegration. More or less inorganic matter will be found on careful examination.

The morphological elements are a moderate number of columnar epithelia, a few leukocytes, a few erythrocytes, and occasional hyaline globules.

*An important ingredient of the prostatic secretion is its specific enzyme. Its exact action is imperfectly understood, but it supposedly coagulates the secretion of the seminal vesicles and favors retention of the seminal fluid within the female genital canal, thus promoting impregnation.*

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## CHAPTER XXVIII

### INJURIES AND DISEASES OF THE PROSTATE GLAND

#### A INJURIES OF THE PROSTATE GLAND

**Etiology** Injuries to the prostate gland are of three types (1) injury from an external source, (2) internal injury, incurred during instrumentation, (3) operative injury

*Injuries from external sources* do not often affect the prostate in its protected situation. Such injuries vary from contusions to extensive lacerations or complete rupture in conjunction with severe injuries to neighboring structures. Ordinarily the pubic and ischial rami and the ischial tuberosities protect the prostate from injuries such as befall the urethra below and the bladder above as the result of falls or blows. Even in accidents that bring violent force to bear upon the perineum the prostate is likely to escape, because the tissues of the anoperineal region and the ischiorectal fossa are so elastic that they constitute a sort of cushion of muscular and cellular structures that takes the brunt of the violence. Occasionally the prostate is involved in gunshot wounds or injured by impalement on sharp objects or torn off from the prostatic urethra. In severe fractures of the pelvis there is sometimes extensive traumatization of the prostate generally in association with severe injury to the surrounding structures. Exceptionally, however, the gland may be pierced by a fractured pelvic bone when the adjacent tissues are not greatly damaged.

*Internal traumatization* due to improper instrumentation is more common. If the instrument used is small and sharply pointed even a normal prostate may suffer injury, for the urethra makes a sharp curve in the region of the triangular ligament, and a catheter may be impeded in the bulb, when the external sphincter is spasmodically closed so that instead of traversing the route intended the instrument may pierce the urethral wall, pass through the perurethral tissues and penetrate one of the prostatic lobes. It is by no means uncommon to see a false passage coursing through the prostate which has its commencement in the prostatic urethra or somewhere in the urethral wall anterior to the apex

of the gland The cause of these false passages is usually enlargement of one or more of the prostatic lobes or a urethral stricture, which renders the shape of the urethra so irregular and abnormal as to make the proper passage of a catheter or other instrument practically impossible The various problems presented by catheterization have been discussed on page 79, and the possibility of prostatic injury only emphasizes the need of the utmost care and gentleness in every manipulation of this kind

*Operative traumatism* is also relatively common In practically all perineal procedures and operations at the vesical neck the integrity of the prostate is more or less hazarded Increased anatomical knowledge and improved technic have served to lessen these dangers, but the likelihood of injury must ever be borne in mind and every effort made to prevent its occurrence

**Pathology** The complications of prostatic injury vary according to the extent of the lesion Hemorrhage is especially to be guarded against The prostatic area is extremely vascular and rather difficult of access for the application of hemostatic measures Hemorrhage may be externally, through the urethra, or internally, into the bladder or pelvis Blood passing into the bladder may form clots of sufficient size to cause obstruction Retention of urine, from congestive or inflammatory occlusion of the urethra, or from complete or partial obliteration of the canal as a result of the injury, is also common In extensive trauma of the prostatic substance with rupture of the prostatic urethra, there may be extravasation of urine and blood, the direction of the extravasation depending upon the location of the injury Septic cellulitis and pyogenic infection and abscess possibly followed by urinary fistula are serious pathological sequelae of severe injuries of the prostate, especially when drainage is imperfect The cellulitis may be limited to the anoperineal region and the ischiorectal fossa, or it may extend over a large area of the subcutaneous and intramuscular planes of cellular tissue If the wound extends beyond the bounds of the prostate, septic pelvic cellulitis or general peritonitis may develop Incontinence of urine is another common aftermath of injury of the prostate and vesical sphincters

**Diagnosis** The diagnosis of injury to the prostate is sometimes difficult A history of instrumentation, followed by a chill, hemorrhage, and difficulty of urination is suggestive So, too, is a history of pelvic fracture or other external trauma with difficulty in urinating or complete retention, bleeding, and symptoms of extravasation The symptoms vary greatly, depending on the extent and location of the injury

and the complications If the prostatic urethra has been ruptured, there will be bleeding from the urethra and extravasation of urine, or urinary obstruction and distention of the bladder with urine and blood clots Apparently slight injury due to a false passage may lead to extravasation and deep-seated infection

**Treatment.** Treatment is directed to the control of hemorrhage, restoration of normal urinary function, and, if extravasation has occurred, to the complete drainage (both perineal and prevesical) of the extravasated areas Since more important injuries to other structures are usually present when the injury is from an external source, these must first be attended to The treatment of rupture of the urethra is discussed on pages 637 and 679 Cases of instrumental injury, with mild symptoms, frequently require no treatment other than withdrawal of instrumentation

Later sequelae, such as strictures, fistulas, false passages, and incontinence of urine, must be treated surgically as a rule

## B DISEASES OF THE PROSTATE GLAND

### *Prostatitis*

Prostatitis is a very common disease It may occur as an isolated abnormality, but rarely does Posterior urethritis is practically always present and in most cases the seminal vesicles share in the pathological process Frequently, there is associated infection of the vesical neck, trigone, and even of the epididymes Inflammations of the prostate should, therefore, be studied in relation to both the urinary and the genital tracts

### ACUTE PROSTATITIS

**Etiology and Bacteriology** The most frequent cause of acute prostatitis is gonococcal infection Some involvement of the prostate will follow practically every case of posterior urethritis Non specific acute infections are also common and have of late years received a great deal of study Careful observations by numerous writers who have made studies upon prostatitis and prostatovesiculitis show that besides the gonococcus, the *Staphylococcus albus* and *aureus*, *Streptococcus pyogenes* colon bacillus diphtheroid bacillus and other organisms may be present Mixed infections are frequent The prostate is undoubtedly one portal for septicemia, and, when the gonococcus is the offending organism it is practically always the original focus

Contributing causes of acute prostatitis are sexual abuse (masturbation, coitus interruptus, excessive intercourse, etc.), instrumental or other traumatism, or anything that causes prolonged congestion of the prostate.

Infection may reach the prostate in a number of ways. The most common is probably by direct extension from the posterior urethra up the prostatic ducts. A chronic prostatitis may be exacerbated into an acute condition by unwise instrumentation and manipulation in the treatment of a chronic posterior urethritis and prostatitis. The prostatic infection may be descending, and secondary to an acute infection of the

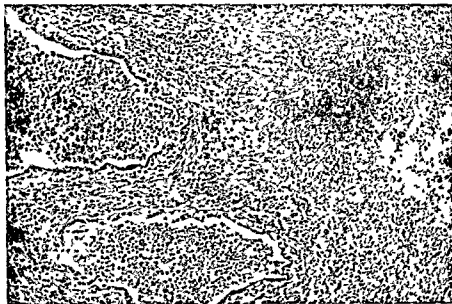


FIG 161 Acute suppurative prostatitis. Photomicrograph. Leukocytes are seen in the alveoli and interstitial tissue. Many of the glands have broken down.

kidney or bladder, or it may be blood-borne from a primary focus in the sinuses, tonsils, or teeth, or a complication of a systemic infection, such as *influenza*.

**Pathology.** Three types of acute prostatitis are generally recognized: (1) acute catarrhal inflammation, which is always present in acute posterior urethritis and is usually caused by direct migration of the gonococcus or other organism from the posterior urethra up the prostatic tubules, (2) follicular prostatitis, which follows the first type and is characterized by the formation of multiple small abscesses and distention of the prostatic tubules with pus, which is not evacuated because of edematous or other obstruction of the ducts; (3) parenchymatous prostatitis, an in-

tensification of the second stage, the small suppurative foci becoming larger and involving a greater extent of the surrounding stroma. Swelling, tenderness, tenseness, and heat are readily felt by rectum.

The termination of acute prostatitis is resolution, or the formation of a large prostatic abscess, or chronic prostatitis.

**Symptoms** The onset of acute prostatitis may be mild, with few or no symptoms referable to the prostate, urethra, or bladder, or it may be so severe as to simulate acute peritonitis. The initial symptoms in acute prostatitis of urethral origin, are usually disturbances of urination: urgency, frequency, burning, pain at the beginning, during, and at the end of urination, dribbling at the end of micturition. The prostate may



FIG 162 Photomicrograph showing a small abscess of the prostate consisting of a central necrotic area surrounded by a connective tissue wall. Outside this are seen some prostatic tubules filled with exudate.

enlarge to the point of causing complete urinary retention requiring catheterization. In acute prostatitis of hematogenous origin, the attack may be ushered in by a chill or a sudden rise in temperature and there may or may not be urinary symptoms. Pain may vary from a sense of fulness in the perineum or rectum, to acute pain—in the perineum, rectum, sacrum, loins, penis, down the thighs or above the pubes. There will be leukocytosis.

**Diagnosis** Mild prostatitis is likely to escape observation during the course of an acute posterior urethritis. In severe cases, rectal palpation of a symmetrically enlarged, hot, tender gland is sufficient, with the symptoms and the findings of the two-glass urine test to establish a diagnosis.



Differentiation, clinically, between acute diffuse parenchymatous prostatitis, with or without multiple milary abscesses, and prostatic abscess of gonococcal origin is difficult. Acute prostatic abscess is an unfrequent complication of acute gonorrhea and is less serious than the quite common pyogenic abscess. In the early stage, acute inflammation and abscess present the same clinical picture: urinary symptoms, leukocytosis, with rectal pain, swelling, tenderness, and heat on palpation. Each may run a febrile course, but as a rule chills occur only with abscess. An acute prostatitis, however, usually improves rapidly, as is evidenced by a decrease in the leukocyte count and in the size and sensitivity of the prostate on palpation, whereas in abscess, the urinary difficulties, pain, and leukocytosis increase, and the prostate becomes larger, more tender, and asymmetrical. The suppuration may extend into the periprostatic tissues in which event the glandular outline will be lost in the edematous swelling. Unrecognized or untreated abscesses may progress to spontaneous rupture, usually into the urethra but occasionally into the bladder or peritoneum (with serious results), or they may burrow into the rectum or perineum.

**Treatment** Treatment of acute prostatitis is expectant, and consists in absolute rest in bed for all febrile cases and the avoidance of physical strain and sexual excitation in all cases, avoidance of trauma to the gland by unwise instrumentation, the application of heat in the form of hot sitz baths, hot rectal irrigations, or diathermy, sedatives and belladonna and opium suppositories for pain, alkalinization of the urine, forced fluids if there is no urinary retention, and chemotherapy (see Non-Operative Treatment of the Prostate, p. 935).

If the patient is having difficulty in voiding, it is important to ascertain whether there is residual urine. While the catheter is in position, the bladder should be irrigated with a mild antiseptic solution such as acriflavine, 1:8,000, rivanol dextrose, 1:8,000, or potassium permanganate, 1:10,000 or 1:8,000.

Aside from necessary catheterization, urethral instrumentation, as well as massage of the prostate, is contraindicated in the acute stage.

#### CHRONIC PROSTATITIS

Chronic inflammation of the prostate is a very common condition in adult males, and is frequently, but by no means always, due to gonococcal infection. In recent years, with the carrying out of more careful bacteriological studies, many cases of non-specific prostatitis have been found. Pyogenic and gonorrheal infections are frequently combined.

In our series of 350 postmortem studies, a large number of the specimens showed evidence of inflammation of the prostate gland

The chronically infected prostate may assume an important role as a focus of infection, and urologists have repeatedly emphasized the importance of examining the prostate and the prostatic secretion when searching for the source of obscure infectious conditions. We regard the prostate as second only to infected tonsils as a cause of arthritis. It may also be responsible for endocarditis, neuritis, iritis, and myositis. In view of the frequency of chronic prostatic infections, it is amazing how infrequently chronic prostatitis is searched for in the routine examination of patients, and how often the prostate is overlooked in the search for a focus of infection. This may be due in part to the fact that chronic infection in the prostate often produces no local symptoms.

**Etiology and Bacteriology** Chronic prostatitis is most frequently the sequel to an acute infection, which may be caused by either the gonococcus or other microorganisms. Various authors have estimated the frequency of acute prostatitis as a complication of gonorrheal urethritis at from 50 to 90 per cent, and untreated acute gonorrheal prostatitis, or incompletely treated posterior urethritis, is undoubtedly the most important factor in the production of chronic prostatitis. It is our observation that after every case of posterior urethritis the prostate is more or less involved, this involvement being manifested by the persistence in the urine of comma shaped casts of the prostatic-duct orifices, nodulation and induration of the prostate gland itself, and the appearance of more than the usual quantity of pus cells in the prostatic fluid. Only immediately after the inflammation has subsided is the gonococcus to be found. In a study of 1,000 unselected cases of chronic prostatitis Kretschmer (1937) found gonococci in the prostatic strippings of only 24.

All cases of chronic prostatitis are not, however, of gonorrheal origin. A surprisingly large number of patients with prostatic infections have never had gonorrhea in the recent or remote past, and the common viewpoint that chronic prostatitis is a venereal disease is an injustice to many patients. These non specific cases are called chronic pyogenic prostatitis. Pyogenic infection of the prostate may be a direct extension from the urethra, but frequently the source of infection is hematogenous, the foci being located most commonly in the tonsils, teeth, or sinuses, or it may follow an acute systemic infection, such as influenza or typhoid fever. It is important, therefore, that the character of the offending

bacteria be demonstrated and the focus of infection determined. Mixed infections are common. A non-specific prostatitis is frequently present at the time of contraction of a gonorrheal urethritis, and persists after the gonococcus has disappeared.

In nearly all cases of prostatic abscess—whether gonorrheal or non-specific—there is an associated prostatitis. Surgical drainage or spontaneous rupture of the abscess is usually followed by subsidence of the

TABLE IV

AGE	MOST PROMINENT SYMPTOM	ORGANISM DEMONSTRATED
48	Pain in back, legs, shoulders	<i>Staphylococcus aureus</i>
30	Pain in chest, marked nervousness	<i>Staphylococcus aureus</i>
29	Myositis, polyarthritis	<i>Staphylococcus albus</i> , 2 diphtheroid types
30	Perineal pain	<i>Staphylococcus albus</i> , <i>Streptococcus viridans</i>
35	Pain in back, legs, perineum	<i>Staphylococcus albus</i> , <i>Bacillus pyocyaneus</i> , <i>Micrococcus vaginalis</i>
32	Pain in knees	<i>Staphylococcus aureus</i>
45	Pain in neck, right shoulder, back	<i>Staphylococcus aureus</i> , <i>Micrococcus tetragenus</i>
34	Severe arthritis of knees	<i>Streptococcus viridans</i>
35	Pain in back, legs, joints	<i>Staphylococcus pyogenes hemolyticus</i>
38	Painful exostosis both heels	<i>Staphylococcus albus</i>
28	Persistent urethral discharge, pain in back	<i>Micrococcus gonococcus</i> , <i>Micrococcus tetragenus</i> , <i>Staphylococcus albus</i>
50	Multiple extreme arthritis	<i>Streptococcus viridans</i> , <i>Staphylococcus albus</i> , <i>Bacillus proteus</i>
53	Pain in back	<i>Streptococcus hemolyticus</i> , <i>Pneumococcus</i> ; <i>Staphylococcus aureus</i> and <i>albus</i>
41	Myositis	<i>Staphylococcus aureus</i>
22	Arthritis of ankles	<i>Staphylococcus aureus</i>
34	Pain in perineum	<i>Staphylococcus albus</i> , <i>Micrococcus tetragenus</i>
48	Painful, deformed joints of hands	<i>Staphylococcus aureus</i> and <i>albus</i>

symptoms, but careful examination of these patients will reveal that the prostatic fluid still contains pus, and hence there remains a possible latent focus of infection which, if neglected, may produce chronic prostatitis (Kretschmer, *et al*).

Other possible etiological factors in the production of chronic inflammation of the prostate are sexual abuse, instrumental or other traumatism, prostatic stones, stricture of the urethra, and certain vitamin deficiencies and endocrine dyscrasias. Any prolonged congestion of the

prostate whatever its cause will so lower the resistance of the gland that an infection is likely to develop

Authors differ regarding the types of organisms found in the non specific forms of chronic prostatitis Kretschmer and his colleagues place the colon bacillus at the top of the list Most investigators however—among them Cumming and Chittenden and Ritter and Lippow—find the staphylococcus and streptococcus and their subforms in the foreground of demonstrable organisms Table IV shows the organisms identified in a series of 17 cases of chronic prostatitis studied by us together with the most prominent symptom in each case

**Pathology** The chronically inflamed prostate on rectal palpation may feel perfectly normal or may show marked changes in size and consistency and be adherent

*Microscopically* there are usually to be observed regions of inflammatory reaction in and about the acini characterized by an increase of the polymorphonuclear cells lymphocytes and plasma cells with marked proliferation of connective tissue In other cases the micropathological changes consist in circumscribed areas of round cell or polymorphonuclear cell infiltration Minute abscesses are sometimes observed

In a large percentage of cases of chronic prostatitis cystoscopic examination will show pathological changes around the bladder neck and the prostatic urethra particularly the verumontanum Sclerosis of the bladder neck which is a secondary change from a long continued prostatitis may be difficult to differentiate from a true fibrosis of the bladder neck Trigonitis is frequently present In most instances there is more or less involvement of the seminal vesicles which may be soft and atrophic or enlarged and indurated Dilatation and atony of the ureter particularly the lower portion is a not uncommon complication of prostatovesiculitis

**Symptoms** The signs and symptoms of chronic prostatitis vary greatly Some patients complain only of a urethral discharge which may be profuse or merely the so called morning drop Others have urinary symptoms frequency burning urgency difficulty pyuria hematuria and dribbling—symptoms resulting largely from involvement of the posterior urethra and bladder neck Still others have predominant sexual symptoms loss of libido weak painful or absent erections premature painful or bloody ejaculations frequent nocturnal emissions sterility, prostaticorrhea Frequently the predominant symptoms are metastatic with absence of local symptoms so that the prostate is not

suspected as a source of infection. The most common metastatic lesions are arthritis, neuritis, iritis, and myositis.

The most frequent complaints are of pain, "morning drop," and some disturbance of sexual function, always accompanied by neurasthenia. Pain may be local or referred. Ordinarily it is located in the perineum, and may be described simply as a "heaviness" in the rectum. With this type there is generally a history of the passage of prostatic fluid on defecation. The pain may be referred down the back or inner sides of the legs, or into the groins, penis, or sacrum, or it may simulate that produced by renal calculus. Frequent and painful urination, urgency, and difficulty are all common complaints. Examination of the urine practically always shows shreds, usually comma shaped casts of the prostatic duct orifices.

If abscess occurs in the course of a chronic prostatitis, which is not uncommon with pyogenic infections, there is increased leukocytosis and pain, chills, and a rise in temperature. Rectal palpation will reveal enlargement of the gland, greater sensitivity, and differences in consistency.

**Diagnosis.** The history, as we have seen, is frequently negative, and the prostate likely to be overlooked.

The diagnosis of chronic prostatitis should be based on (1) rectal palpation, (2) repeated analyses of the voided urine, (3) microscopic examination of the prostatic secretion and ejaculate, and (4) urethroscopic examination of the posterior urethra and vesical neck. It is often wise to delay this last procedure until the most distressing symptoms have been allayed by treatment. Urethroscopy will reveal associated pathological changes of the prostatic urethra and verumontanum, bladder neck, and trigone. Attention must also be paid to the seminal vesicles, which frequently are also involved.

**Rectal Palpation.** Rectal palpation, though of the greatest importance, is not of itself sufficient to establish the diagnosis of chronic prostatitis, since not infrequently palpation of the chronically inflamed gland may reveal no gross changes, yet pus cells will be found in the prostatic strippings. Many a prostate that feels normal functions poorly and contains large amounts of pus and debris, and many microorganisms.

In many cases, however, careful rectal examination will reveal palpable changes in and about the gland. It will be hard and nodulated, and usually adhesions can be felt extending from the lateral borders of the gland to the seminal vesicles and adjacent pelvic tissues. Such a prostate is ordinarily, but not always, enlarged, and sometimes there are

boggy spots between the areas of induration. Areas of normal gland are usually present, particularly in non specific infections.

*Examination of the Urine* Examination of the urine practically always shows shreds, usually comma-shaped casts of the prostatic-duct orifices.

*Examination of the Prostatic Fluid* Microscopic examination of the secretions expressed by massage of the prostate is the only reliable method of demonstrating the presence of infection in the gland. In treating a case of chronic prostatitis, frequent microscopic examinations of the unstained prostatic fluid should be made, as the conditions present in the gland can be ascertained in this way much more accurately than by palpation. Often the diagnosis must rest solely on microscopic evidence of pus in the expressed secretions. Changes in the secretion are much more frequent than alterations in the prostate evidenced by palpation.

Negative findings on one examination of prostatic secretion are, however, insufficient proof of the absence of prostatitis, since pus in some instances does not make its appearance until after the prostate has been massaged from two to five times. The secretion expressed after the first massage may be entirely from the normal portions of the gland and two or more manipulations may be necessary to open a pathway into the urethra from a closed-off focus of infection. We have observed that after massage has been carried out over a long period the induration sometimes disappears entirely but the prostatic fluid remains loaded with pus. After persisting for some time, this condition may suddenly alter, the pus disappears from the fluid, and rapid cure takes place.

Massage for diagnostic purposes must, of course, be carried out firmly enough to express the secretions, but very gently and cautiously. Epi didymitis is a common result of a too vigorous examination.

The prostatic fluid should be stained at least once, to ascertain the presence or absence of bacteria, and their nature. Bacteria are more readily identified on smear than in culture, but many of the more chronic cases fail to show bacteria either on smear or in culture.

**SECURING THE SPECIMEN** For securing an uncontaminated specimen of prostatic, or postatovesicular, secretion, the following method has been found useful. The patient having passed his urine, the penis and meatus are carefully cleansed with green soap and water, and the anterior urethra irrigated with rivanol dextrose 1 5,000, acriflavine 1 5,000, or other suitable antiseptic solution. The patient then kneels on the operating table and a small sterile endoscopic tube is inserted to a point beyond the external sphincter into the prostatic portion of the urethra. He then

bends over and rests on his hands or elbows. The prostate is massaged firmly but gently and each vesicle stripped in turn, and the prostatic urethra finally emptied by several vigorous strokes of the operator's fingers down the middle depression of the prostate. The uncontaminated prostatovesicular fluid is received in a sterile test tube which the assistant holds at the end of the endoscope.

This method may also be used for the *separate* collection of the secretions from the prostate and each seminal vesicle, care being taken, during *massage of the prostate, to avoid the vesicular areas*.

The separate secretions from the prostate and each seminal vesicle may also be recovered from the bladder contents, voided immediately after massage and stripping. The patient having voided his urine, the bladder and urethra are irrigated with rivanol dextrose or acriflavine, 1:5,000 and the bladder refilled with the solution. The prostate is massaged thoroughly, care being taken to avoid the vesicular areas. The patient immediately voids, the voided fluid containing the prostatic secretion. The bladder and urethra are again irrigated, the bladder is refilled with the antiseptic solution, and the right vesicle is stripped. The patient again voids, the voided fluid in the second vessel containing the secretion from the right vesicle. The process is repeated for the left vesicle.

**ESTIMATING RESULTS** The normal prostatic fluid is opalescent and slightly viscid, and microscopically is seen to consist of corpora amylacea, lecithin globules, columnar epithelia, and occasional hyaline globules (Physiology of the Prostate Gland, p. 802).

In chronic prostatitis, the prostatic secretion is less opalescent than the normal fluid, and the normal elements are replaced by pus cells and degenerated epithelial cells. The degree of infection is measured by the amount of pus in relation to the lecithin. In a well developed chronic prostatitis much of the lecithin content of the prostatic fluid will be replaced by pus cells, often in clumps. As the condition improves, the pus cells gradually diminish and the normal elements reappear. Bacteria may be present in great numbers. The bacteria are usually staphylococci, streptococci, gonococci, bacilli of the colon group, *B. dysenteriae*, and *B. proteus*.

**Urethroscopic Inspection** Urethroscopic examination of the prostatic urethra and bladder neck should be done in every case of chronic prostatitis, although it is advisable to postpone this procedure until the most distressing symptoms have been alleviated by treatment. Verumon-

tanitis, resulting in sexual disturbances, is a common accompaniment of both acute and chronic prostatitis, and the marked chronic inflammatory changes not infrequently revealed by urethroscopy may provide the only clue to a low grade prostatitis and seminal vesiculitis

**Prognosis** The patient suffering from long standing prostatitis is not easily cured and it is advisable to so inform him at the outset of treatment. The symptoms, particularly the neurasthenia accompanying this condition, are frequently out of all proportion to the gravity of the lesion and respond slowly to any method of treatment. Relief of symptoms by some form of therapy, especially urethral dilatation, massage, chemotherapy, and rectal heat, is possible in most cases, but reversion to a normal prostatic fluid is more difficult to obtain and requires complete removal of infectious foci and restitution of drainage.

**Treatment** In general, treatment consists of dilatation of the prostatic urethra, prostatic massage, urethrovessical irrigations and instillations, heat applied in the form of hot rectal irrigations or hot sitz baths, diathermy, chemotherapy, and vaccine therapy and bacteriophage in selected cases. These are described under Non Operative Treatment of the Prostate Gland (p. 935).

General measures include the restriction of physical and sexual activity and the avoidance of constipation. When there is marked bladder irritation, the patient should be put on a diet which limits tea and coffee and eliminates alcohol, spices and foods that are irritating to the bladder (tomatoes, asparagus, berries, carrots, etc.). Adequate vitamin intake is important.

The elimination of distant foci of infection, in the tonsils, teeth, sinuses, or colon, is of the greatest importance. In these cases, local measures are useful in the relieving of symptoms, but are of relatively little value in cure of the prostatitis which frequently cannot be cleared up without removal of the primary focus.

The main problem in the treatment of chronic prostatitis is the restitution of free drainage, since retention favors infection. The simplest and most effective method of restoring the patency of occluded or obstructed prostatic and ejaculatory ducts is by a gradual, gentle, but thorough dilatation of the posterior urethra to its maximal capacity. Urethral dilatation should therefore, precede massage of the partially or totally retentive gland. Massage of the infected prostate is of benefit only when drainage can take place through patent ducts.

Dilatation is best carried out by means of sounds (passed upon a blad-



der partly filled with a mild antiseptic solution) The sounds are increased number by number, proceeding slowly and with as little trauma as possible until the caliber of the urethra is approached No more than three sizes of sounds should be passed in any one session, and the previously passed largest size should be repeated on each occasion Dilatation is carried on in this manner two or three times a week, until the largest possible sound has been passed on at least three occasions and has remained tight, indicating that the maximal capacity of the urethra has been reached

Active instrumentation is permissible in most cases at the time of the first consultation, the only clinical requirement being a clear first glass of urine The voided urine should be examined before each instrumentation in order that treatment may be discontinued whenever the urine becomes cloudy During dilatation a mild urethritis may develop when the occluded ducts resume drainage and empty their infectious contents into the urethra It may then be necessary to employ urinary antiseptics, the choice of an antiseptic depending upon the nature of the infecting organism Clinical proof of improved drainage can be obtained by a comparison of the amount and composition of the secretion before and after dilatation

When satisfactory drainage of the diseased prostate has been restored, digital massage may be given once or twice a week upon a bladder partially filled with antiseptic solution The aims of prostatic massage are (1) the gentle expression of the accumulated secretion (2) a stimulation of the contraction of smooth muscle fibers and (3) the stretching and final removal of marginal adhesions A moderately forceful massage of the satisfactorily draining prostate may be continued indefinitely without ill effects

Repeated microscopic examinations of the prostatic secretion should be made in every case during the course of treatment

Hyperpyrexia and vaccines, serums, and injections of foreign proteins have a limited usefulness Hyperpyrexia has been found highly beneficial in certain severe cases of prostatitis complicating gonococcal posterior urethritis, but it is expensive, very uncomfortable, and attended with considerable risk It should be given only in a hospital, under expert supervision Intraprostatic injections of antiseptic solutions have been recommended for recalcitrant pyogenic prostatitis Our experience has been that the benefits are not sufficient to offset the hazards of this method, which have been clearly shown by the experimental

studies of O'Connor and Ladd. Intraprostatic injections, we believe, should be used very cautiously and only in carefully selected cases. Since sulfanilamide, orally administered, has been definitely recovered in the prostatic secretion, we feel that the oral method is more efficient and less dangerous. The efficacy of the sulfonamide drugs in both gonococcal and non-specific prostatic infections has given a new hope in the field of chemotherapy.

Occasionally a prostate becomes so infected that no amount of treatment by the above methods will effect a cure. In such cases, total prostatectomy is indicated. If a prostatic abscess forms, perineal exposure and surgical drainage is usually to be preferred to waiting for spontaneous rupture to occur.

### *Prostatic Abscess*

**Etiology** Abscess of the prostate gland may follow failure of an acute diffuse parenchymatous prostatitis to subside or to become chronic. Multiple small abscesses in the prostatic stroma coalesce to form one large abscess.

Gonococcal prostatic abscess, formerly a common complication of specific posterior urethritis and acute prostatitis, is now infrequently encountered due to the widespread use of sulfonamide therapy in gonorrhea. Our own studies have shown that many other organisms may be present in abscess cavities in the prostate. Of 59 cases of prostatic abscess occurring on our service, 20 patients denied ever having had gonorrhea and 10 had had the disease many years previous to the development of the abscess. Prostatic abscesses may result from too strenuous urethral instrumentation, or be associated with urethral stricture. In these cases there is usually an underlying prostatitis. They are often metastatic and occur as a complication of influenza, typhoid fever, septicemia, pyemia, or diabetes mellitus, or they may be secondary to superficial pyogenic infections such as carbuncles, boils and felons. In the latter event, the causative organism is the *Staphylococcus aureus*. These quite common pyogenic abscesses are usually more serious than gonococcal prostatic abscesses.

**Symptoms** The symptoms of prostatic abscess are pain in the perineum, chills, rise in temperature, and frequent and painful urination which may progress rapidly to complete retention. Leukocytosis is present.

There are occasional cases of huge prostatic abscesses in which the only

symptom is difficulty of urination. There may be neither pain, fever, nor a high leukocyte count. This is due to the type and lack of toxicity of the infecting organism.

Chronic abscess of the prostate may develop insidiously and persist for weeks without producing local symptoms.

With deep seated "closed" abscesses—namely, abscesses which do not drain into the urethra—there may be little or no pus in the urine.

**Diagnosis.** Urinary difficulty and retention in a patient with a history of recent pyogenic infection is suggestive of metastatic abscess of the prostate.

The diagnosis is often made without difficulty, upon the history and the rectal palpation of an enlarged, asymmetrical, tender gland. The presence of fluctuation leaves no doubt as to the diagnosis. If no fluctuation is detected, a needle may be inserted into the suspected portion of the gland and pus withdrawn, if present.

If neither fluctuation nor pus is noted, a cysto-urethrogram may be helpful in arriving at a correct diagnosis. In "open" abscess—namely, an abscess which communicates with the urethra—the cavity will be outlined by the contrast solution, making diagnosis easy. In "closed" abscess, the posterior urethra is usually elongated and narrowed, and pressure of the abscess causes a more or less S shaped deformity of this portion of the urethra. Commonly there is intravesical deflection of the contrast medium, with poor or no visualization of a soft tissue shadow at the vesical orifice.

**Prognosis.** The prognosis is poor if the abscess is untreated. The abscess may then rupture into the urethra or rectum, or it may burrow into the perineum, bladder, or even into the peritoneum. In such cases, the mortality is high, and, if death does not ensue, the convalescence is prolonged and complications serious. Abscesses which empty their entire contents into the urethra are likely to be of the follicular type, or at least not deeply seated in the parenchyma. Spontaneous evacuation through the rectal wall can only be regarded as a surgical calamity. The establishment of a recto urethral fistula is almost certain to follow, and this may prove highly intractable to treatment, if, indeed, it is not found altogether impossible to make it close.

If proper drainage is instituted, convalescence is usually satisfactory, although every case of prostatic abscess must be followed by a long course of treatment to insure a normal gland.

**Treatment.** The treatment of prostatic abscess is by incision and

drainage, preferably through the perineum (Operative Treatment of Prostatic Abscess, p 929)

### *Syphilis of the Prostate*

**Incidence** Syphilis of the prostate appears to be exceedingly rare. Very few cases are to be found in the literature and text books barely mention the subject. We have personally never encountered a case of prostatic syphilis. Just why the prostate, which seems peculiarly liable to harbor practically every other type of infection, should be immune to such an ubiquitous disease, is a question not without interest.

The literature upon the subject was reviewed in 1920 by Thompson who found 24 recorded cases, 12 of which he considered doubtful. Since then, Warthin (1918), McDonagh (1922), Starry (1924), Salleras (1925), W. H. Hames (1926), Riba (1928-1929) and several others have published communications concerning syphilis of the prostate, but it still remains one of the most infrequently encountered infections of this gland.

**Pathology** In all the reported cases of prostatic syphilis irregular enlargement of the gland was the chief feature of the gross pathology. Nodulation also was frequently mentioned.

The prostate may show all stages of syphilis in varying degrees, from the early miliary gumma to the old, healed, scarred lesion.

Warthin and Starry have each published a good microscopic description of a syphilitic prostate, their findings being essentially similar. Diffuse plasma cell infiltrations were present throughout the prostatic stroma, the infiltration being perivascular and interstitial, and not periglandular or subepithelial, as is often seen in gonococcal prostatitis. Fibroblastic and angioblastic proliferations were prominent, and numerous giant cells occurred in the larger infiltrations, giving them the character of miliary gummas without caseation. Groups of spirochetes were found in these on staining.

**Symptoms Signs Diagnosis** Pain in the perineum, sometimes independent of, but in most cases aggravated by, urination is the most common manifestation. More occasional symptoms are hematuria, pain on defecation or coitus, urinary frequency and difficulty and retention. Prostatic massage usually produces an exudate that is more or less characteristic. The urine is cloudy as a rule and on microscopic examination, shows pus, epithelial cells, and some blood corpuscles. On rectal palpation the prostate will be found markedly irregular, enlarged and sometimes nodular. The most common cystoscopic findings are lateral

lobe enlargement and irregularity, with edema and sometimes thickening of the bladder neck and trigone. The Wassermann test is usually positive.

Prostatic syphilis is a late manifestation of lues and occurs as a rule between the ages of 40 and 65 years. It may be very difficult to differentiate between syphilis and hypertrophy of the prostate, which is common in this period of life and is attended by similar symptoms. Differentiation between syphilis and carcinoma may also be difficult, and in many of the reported cases the condition was first diagnosed as malignancy.

**Prognosis** If the diagnosis is made early, the disease responds readily to the ordinary antiluetic treatment. If unrecognized, the prostate may be destroyed by gummas.

**Treatment** Treatment consists of the usual antileutic measures, reinforced by surgical drainage of necrotic gummas.

### *Tuberculosis of the Prostate Gland*

**Etiology and Incidence** Tuberculosis of the prostate gland is a disease of the young adult, and as a rule, is observed in those in the third and fourth decades of life. It is usually part of a progressive infection that is extending throughout the genital or urogenital system. Most commonly it is found in association with tuberculous infections of the epididymes, vasa deferentia and seminal vesicles, less often as an accompaniment of urinary tuberculosis.

Primary prostatic tuberculosis appears to be extremely rare. It is probable that even today the possibility of tuberculous invasion of the prostate is commonly overlooked in patients who are beyond the age usually associated with liability to urogenital tuberculosis, and who are passing through the period when both benign and malignant hypertrophy are common.

A review of the literature by Lowsley and Duff, in 1930, showed that tuberculosis of the prostate is present in about 70 per cent of cases of urogenital tuberculosis. This figure corresponds fairly well with our personal observations. In our series, numbering well over 1 000 cases of urogenital tuberculosis, between 50 and 70 per cent showed involvement of the prostate. In the great majority of cases the prostate was secondarily involved in a progressive tuberculosis which was extending throughout the urogenital system. The relative frequency of such

secondary involvement is readily understood when one considers the prominent position of the prostate at the junction of the urinary and genital tracts. It is obvious, therefore, that when tuberculosis of the urogenital tract is discovered, a careful examination of the prostate should always be made, even though there may be no symptoms pointing to the gland.

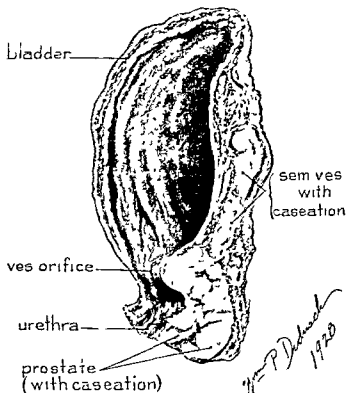


FIG. 163 Tuberculosis of the prostate gland and seminal vesicles with caseation (Christeller)

In most instances tuberculosis of the prostate is probably an extension from the seminal vesicles. The primary focus of urogenital tuberculosis is believed to be most often in the lungs, less frequently in the bones, larynx, glands or alimentary canal, whence it spreads through the lymphatics, finally invading the blood stream. The lungs should always be most carefully examined in all cases where tuberculosis is apparently confined to the urogenital tract.

Whether urogenital tuberculosis starts in the kidneys, in the epidid-

ymes, or in the seminal vesicles and prostate, it tends to spread from one portion of the tract to another, either by direct extension, or by the lymphatics, or through the urinary or seminal channels. Consideration of the entire tract is therefore important.

**Pathology** In most cases of prostatic tuberculosis there is involvement of one or both seminal vesicles and at first the prostatic lesion may be confined to the region about the ejaculatory duct on the side corresponding to the infected vesicle, whence it spreads by way of the acini or by the lymphatics to other portions of the gland. Occasionally the epididymis, vas deferens, seminal vesicle, and kidney on one side will be diseased and the other side entirely free. One may then find tuberculous nodules and even abscess formation on the corresponding side of the prostate gland, and the other side comparatively or entirely free of disease. In the rare cases in which the prostate is infected by tubercle bacilli conveyed in the urine, the initial lesion is penilethral. This immunity of the prostate to infection in many cases of renal tuberculosis is indeed surprising inasmuch as the posterior urethra and prostatic duct orifices are almost constantly bathed in infected urine, sometimes for many years.

As with tuberculosis elsewhere, the first pathological change is the formation of tubercles. The tubercle bacilli are apparently first deposited in the walls of the small capillaries. Other tubercles develop from these original foci and extend in the usual manner, the bacilli being observed as a rule at the borders of the tubercles. Later stages are fibrosis, caseation, and suppuration. Suppuration may result in rupture of an abscess through the prostatic capsule, with the formation of a very intractable perineal fistula, or there may be rupture into the urethra. Spontaneous healing is rare. Small caseous areas may become encapsulated and latent, or they may undergo calcification and encapsulation.

Thomas N. Hepburn (1936) reported a very interesting case of 'auto-prostatectomy' due to tuberculosis, which he believed to be unique. In this case infection was carried by the urine from an infected kidney through the prostatic ducts into the prostate, with no apparent evidence of involvement of the seminal vesicles and epididymes. There was complete destruction of the prostate by the tuberculous process, the prostatic tissue having been entirely extruded through numerous dilated ducts in the urethral floor, and its place taken by a diverticulum bounded by the prostatic capsule and opening into the prostatic urethra.

**Symptoms Signs Diagnosis** The symptoms vary with the type of

lesion present In the presence of well walled off tubercles, there may be no untoward symptoms whatsoever If, on the other hand, the tubercles have coalesced and finally ruptured into the urethra, there will be frequency of urination, dysuria, hematuria and pyuria

Rectal examination reveals a nodular, elastic gland, usually affected on but one side, and differing from a carcinomatous condition in that it lacks the board like consistency almost always associated with malignancy of the prostate The secretion may show tubercle bacilli Differential diagnosis is made mainly by means of microscopic study of a specimen of diseased tissue

**Treatment** The hygienic, dietary, and therapeutic measures advocated for postoperative and inoperable tuberculosis of the urogenital tract (p 1196) are usually prescribed, and good results have been obtained therefrom in some cases

Chronic tuberculosis of the prostate gland, like that of other organs, is sometimes accompanied by calcium deposits When such a lesion is present, total prostatectomy is indicated On the other hand, in acute and subacute tuberculosis of the prostate operation is distinctly contraindicated Even in the presence of abscess, it is preferable to allow it to absorb or rupture into the urethra rather than to evacuate it through the perineum, as this is likely to result in a persistent fistula Radical removal of the genital tract is inadvisable in patients with extensive involvement of the prostate gland

#### *Trichomonas Vaginalis Infestation of the Prostate Gland*

The reported cases of *Trichomonas vaginalis* infestation of the prostate gland are exceedingly few Stuhler, of the Mayo Clinic reported that in 32 000 examinations of prostatic secretion the presence of the *Trichomonas vaginalis* was revealed in only 16 cases—in marked contrast to its estimated occurrence in from 40 to 75 per cent of females It appears probable however that the male harbors the organism in his prostate in a higher percentage of cases than hitherto suspected and that the infection has been confused with other non specific infections of the prostate and male urethra

The organism probably gains entrance at the time of coitus

The diagnosis and treatment have been considered under *Trichomonas Vaginalis Infestation of the Male Urethra* (p 641)

#### *Cysts of the Prostate Gland*

**Incidence** Cysts of the prostate gland are of decided rarity (54 cases up to 1936, Emmett and Braasch)



**Etiology and Pathology** Cysts of the prostate gland may be either *congenital* or *acquired*

*Congenital cysts* are very rare, and are usually of the retention type and unilocular. Although often grouped with prostatic cysts, they are actually cysts of the prostatic utricle or of the connective tissue situated between the prostate and the anterior wall of the rectum. They are the result of anomalies such as failure of the müllerian ducts and wolffian bodies to undergo atrophy.

*Acquired cysts* are of several types (1) retention cysts, which arise from occlusion of the prostatic ducts, (2) cystic adenomas, arising from mucous glands, (3) cysts which occur in connection with carcinoma of the prostate, (4) echinococcal cysts, (5) bilharzial cysts. Echinococcal and bilharzial cysts are extremely rare.

Cysts associated with prostatic carcinoma may be (1) secondary to carcinoma of the prostate, or, rarely, (2) primary, but having undergone malignant degeneration after formation (Blanc). Such cysts seldom reach a size permitting clinical recognition.

By far the most common prostatic cyst is the simple retention cyst. This may arise in any portion of the prostate gland, and is merely a normal acinus the duct of which has become occluded, causing expansion of the acinus with thinning out of its simple columnar epithelium. If the cyst is so situated as to project into the urethral lumen or into the bladder, its external surface will be covered with mucous membrane similar to that of the urethra or bladder. A large cyst may be formed by coalescence of several adjacent acini or the fusion of several smaller cysts.

**Symptoms and Diagnosis** A cyst of the prostate, unless it is so situated as to cause obstruction or pressure, may remain undiscovered throughout life. It is probable, therefore, that the small number of the reported cases is no accurate estimate of their actual frequency. Large cysts situated deep in the prostate or near its posterior surface may interfere with defecation. Such cysts must be diagnosed by rectal examination. If the cyst is so located as to obstruct the vesical outlet, frequency, urgency, and other symptoms characteristic of prostatic obstruction may be in evidence. Hematuria is occasionally seen. If much pressure is exerted on the prostatic capsule, there will be perineal or urethral pain. Cysts vary in size from that of a pea to that of an orange. Of the 32 cases collected by Wesson, 12 were "as large as cherries." The amount of residual urine in the bladder will serve to indicate the extent of the obstruction caused by the cyst.

Thick walled cysts may be mistaken for prostatic tumors, and occa

pituitary gland can stimulate the testes to the production of enough androsten to cause hypertrophy of the prostate. *Inhibin* (contrary) the second hormone has not yet been isolated but is postulated on experimental grounds to be a water soluble substance formed by the germinal cells and acting as a control to the pituitary gland. Normally the germinal cells are supposed to secrete enough *inhibin* to prevent excessive secretion of the pituitary hormone but with degenerative changes or



FIG. 164 Cross section of prostate of man 72 years old showing muscular wall of floor of urethra with several light areas which represent early fibromuscular nodules. "U" urethra. Autopsy specimen. Photomicrograph  $\times 125$  (Deming)

decreased function of the germinal cells as in old age the amount of *inhibin* would supposedly be reduced to such an extent that the functional ability of the pituitary gland would be unrestricted. The theory of the Cleveland Clinic workers is that absence of *inhibin* leads to pituitary hyperactivity which stimulates the production of androsten and produces prostatic hypertrophy.

Laqueur of Amsterdam and his coworkers believe that in prostatic hypertrophy there is an improper balance between the male and the estrogenic hormones. In a normal male under the prostatic age the two sex hormones are supposedly in balance with each other and with the

hormones of the pituitary and adrenals. Benign hypertrophy, these investigators believe, is due to a deficiency of the male hormone, so that the hyperplastic action of the estrogenic and other gonadotropic substances is not properly inhibited. Hence, administration of male hormone should restore the hormone balance.

Contrary to the above view, Wugmeister (1937) expressed the opinion that benign hyperplasia of the prostate is due to a deficiency of the *estrone* normally present in males. Treatment of 23 patients with large doses of estrone resulted in marked functional improvement and a decrease in



FIG 165 Cross section of prostate of a man 68 years of age, showing fibromuscular nodule in the muscle wall of the urethra, and, in the opposite muscular wall, a large asymmetrical glandular mass. Autopsy specimen. Photomicrograph  $\times 1\frac{1}{2}$  (Deming)

the size of the prostate. Others have also reported good results from the use of estrogenic substances.

Clyde L. Deming points out that so called adenoma of the prostate is, in reality, a hyperplasia of the prostatic ducts stimulated by solid fibromuscular masses in the muscular wall of the prostatic urethra. These develop centrally beneath the mucous membrane of the posterior urethra. We quote from a personal communication:

Clinicians have long designated the benign enlargement of the prostate as "hypertrophy of the prostate." Pathologists, since the beginning of the twentieth century, have been reluctant to call the lesion an hypertrophy and have termed it instead an "overgrowth" of the prostate gland. Microscopic sections of surgical specimens have shown a preponderance of glandular tissue, some muscular tissue,

and, in a few instances, fibrous tissue. It was natural, therefore, to assume that the enlargement is an overgrowth of glandular tissue which closely resembles the glandular tissue of the normal prostatic gland. Albarran proposed that these glandular tumors are derived from the suburethral glands of the posterior urethra while Marion and Zuckerlandl believed that they originate from glands in any part of the prostate.

For nearly 100 years the coexistence of solid fibromuscular masses and glandular masses has been observed in specimens of so-called prostatic hypertrophy. Vel peau, in 1841, recognized fibromuscular masses. Thompson, in 1873, also found them, and thought that, microscopically, they resembled the myomas of the uterus. From time to time, leiomyomas of the prostate have been described, a few of them large enough to cause obstruction to urination. Patch and Rhea found leiomyomatous nodules in 25.4 per cent of 181 consecutive surgical specimens.

Recognition of the significance of the presence of fibromuscular nodules has been retarded for several reasons: first, the preponderance of glandular tissue in the surgical specimens, second, the glandular nodules occupy positions corresponding to the anatomical positions of the normal lobes of the prostate gland, third, the numerous conflicting theories for the development of "prostatic hypertrophy." Failure to distinguish between hypertrophy and hyperplasia of the tissues of the prostate has resulted in misdirected research. The results of attempts to produce the lesion experimentally, without exact knowledge of its origin or manner of development, cannot solve the problem "*opera nequidquam peri*."

The early phases of the development of benign overgrowth of the prostate have been studied by the examination of serial sections of prostatic glands removed at autopsy from subjects 45 years of age and upward. Only minute masses or microscopic nodules have been utilized. Fibromuscular masses have been found to constitute the primary lesion. They have been observed in the muscular wall of the posterior urethra, anywhere between the verumontanum and the internal vesical sphincter. From 1 to 16 of these masses have been seen in a single prostatic specimen. They are most frequently found near the verumontanum. The fibromuscular hyperplasia begins around a blood vessel. As the nodules enlarge, they are enriched and nourished with newly formed vessels. As they increase in size they become encapsulated. When stained with hematoxylin and eosin and Masson stains, they show the same muscle arrangement and color as the myomas of the uterus, and are devoid of glands.

The secondary phase in the development of the benign overgrowth is the invasion of the solid fibromuscular mass by the epithelium of a duct or gland which lies adjacent to the nodule. It would seem that some inherent quality of the nodule stimulates buds of epithelium in the duct to invade the nodule. The glandular tissue is formed from these buds. Since the glandular tissue grows much more rapidly than the primary fibromuscular tissue, the fully developed surgical specimen may appear wholly glandular. When the primary nodule lies at too great a distance from a duct or gland to influence epithelial proliferation, it may develop into a large leiomyomatous mass sufficient in size to cause obstruction to the bladder.

The hypothetical explanation of the fact that the primary fibromuscular nodule of the prostatic overgrowth simulates the uterine myoma is based on the assumption

that the 2 growths have the same embryological anlage—a muscle cell of the lower müllerian duct system. The observations of Lowsley and Walker on the embryological development of the prostate gland support this hypothesis.

The cause for the development of so-called prostatic hypertrophy in man will probably be discovered in an unbalance of male and female hormones.

**Pathology** Benign hypertrophy of the prostate most frequently occurs in the middle and lateral lobes, the anterior lobe being affected rarely, and the posterior lobe practically never. Carcinoma, on the other hand, begins in the posterior lobe in most cases.

Tandler and Zuckerkandl, in 1912, thoroughly studied the entire subject of prostatic hypertrophy. Dissections of 42 postmortem and operative specimens formed the basis of their report. According to their observations, hypertrophy of the entire gland never takes place. The hypertrophic process, they contended, always begins in the middle lobe, this, as it enlarges, encroaches upon and compresses the other portions of the gland.

Simond's theory is that the submucous glands are the structures which actually undergo hypertrophy, and that the prostate proper—in contradistinction to the submucous glands—undergoes presenile atrophic changes similar in character to those observed in other organs with the advance of age.

Lowsley's studies show that the portion of the gland which enlarges most frequently is really a contiguous structure—the subcervical (Albarran's) group of tubules. These were found to be enlarged in about 25 per cent of men over 30 years of age. This enlargement may occur without hypertrophy of the prostate, but when the prostate proper is enlarged, the subcervical group will also show hypertrophy.

If a portion of the gland protrudes into the bladder, it will usually be found to be the subcervical group of tubules. These can be identified microscopically by the slight tendency of the mucosa to become heaped up and to project into the lumina of the tubules, which are lined with many layers of cuboidal epithelium instead of a single layer of columnar epithelium such as forms the lining of the prostatic tubules. A further point of identification is the absence of the muscular envelop found in the prostate proper. Rarely, there will be an intrusion of the middle lobe, and, when this is the case, the trigonum vesicae will be thinned out and the vesical sphincter so elevated and attenuated as to be practically obliterated. Frequently the subcervical group will be found embedded in the middle lobe. The lateral lobes may intrude in a similar manner.

*Microscopically* four types of benign enlargement may be distinguished (1) glandular (2) cystic (3) fibroglandular, (4) fibrous



FIG. 166 Photomicrograph showing the cystic type of prostatic hypertrophy with the so-called bridging of tissue. This bridging is due to a dilatation of the tubules with thinning out of the intertubular tissue rather than to an outgrowth of the mucosa and actual joining with tissues of the opposite side as was formerly believed. These tubules are lined with a single layer of columnar epithelial cells with the nuclei near the bases.

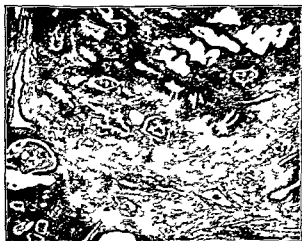


FIG. 16 Photomicrograph showing the fibrous type of prostatic hypertrophy. The tubules are compressed and inconspicuous.

The most common type is the *glandular* which is characterized by a dilatation of the tubules the lumina of which usually show a papillary like intrusion of the mucous membrane due to proliferation of the mucosa

Frequently the tubules have been so distended with fluid that the interstitial tissue between them is reduced to the minimum, producing the so-called 'bridging' effect. Dilatation of the tubules, with thinning



FIG 168 Cross section of cystic type of prostatic hypertrophy. The tubules are seen to be filled with detritus, as well as the mucosa, which has entirely separated from the basement membrane.



FIG 169 Photomicrograph (high power) showing cystic type of prostatic hypertrophy. The mucous lining has disappeared from this specimen.

out of the intertubular tissue, in our opinion offers a more rational explanation of this bridging process than does the older explanation that it is due to an outgrowth of the mucosa and actual joining with tissues of the opposite side.

The second, or *cystic* type, is a further extension of the dilatation process, resulting in the formation of cysts, which are usually small but occasionally are large enough to fill half of the enlarged prostate. In a case observed by us, when the lateral lobe was opened most of the tumor disappeared. Surrounding the distended acini was a layer of fibromuscular tissue of varying thickness.

The third, or *fibroglandular* type of hyperplasia, appears when an unusual amount of fibrous tissue has been laid down. If this process is very intense, there will be a large increase in fibrous connective tissue, or smooth muscle fibers, or both, which will produce a fourth, or *fibrous* type, characterized by marked overdevelopment of the connective tissue and compression of the tubular elements.

Evidences of chronic inflammation may be seen surrounding the acini in specimens illustrating any of these various types. Marked infiltration of small round cells is observable near the basement membrane of the acini. This increase in the cellular elements varies greatly in individual cases and in some instances causes extensive induration.

The much-discussed question as to whether adenomas or fibromyomas predominate in prostatic hypertrophy is of little practical importance, as it is established that a pure formation of either type never occurs. Both types should be differentiated from primary neoplastic proliferation, which should always be regarded as a separate pathological entity.

In prostatic hypertrophy there is a definite line of cleavage between the capsule and the prostatic tissue making separation of the adenomatous prostate from the capsule an easy matter.

**Signs and Symptoms.** The onset of prostatic hypertrophy is usually insidious. The most common symptoms are disturbances of urination. The patient may first notice frequency of urination, then slowness in starting the stream, and shortly thereafter nocturia and dysuria. This may be followed by complete retention of urine, sometimes induced by exposure to cold or damp, indulgence in alcoholic beverages or other irritative factors. The amount of residual urine steadily increases as the mechanism of discharge becomes increasingly impaired until finally, it may trickle out through the obstructed outlet, producing overflow incontinence.

The symptoms are not proportional to the degree of enlargement. Very slight enlargements of the gland, which intrude into the vesical orifice, may produce serious urinary obstruction, while a tremendously enlarged gland, with slight intravesical intrusion, may cause few if any symptoms.



When obstruction to urination does occur, however, there is profound reaction to the back pressure thus caused. The muscle bundles of the bladder wall hypertrophy in their attempt to empty the viscus, causing trabeculations and elevation of the trigonum vesicae, with formation of a deep depression behind the interureteric ridge, referred to as a *bas fond*. The ureters, working against this pressure, dilate, and the kidneys suffer in their ability to excrete the poisons of the body. Thus it frequently happens that at the first examination of a patient with prostatic hypertrophy there will be found extensive damage to the kidney pelvis or even the parenchyma, with corresponding impairment of renal function. The effects of impaired renal function are manifested by constitutional symptoms such as lethargy, dizziness, anorexia, loss of weight, dry skin, and dry, cracked tongue.

Usually the urine shows little abnormality until after infection has set in, when it may contain considerable pus, blood, and albumin. In long standing obstruction, casts are found, and renal function tests will show diminished function.

**Complications** The most serious complications of prostatic hypertrophy are secondary infections in the urinary tract due to obstruction. Cardiovascular and gastrointestinal complications are also very common. Prostatic calculi are sometimes found in conjunction with prostatic hypertrophy, and benign and malignant hypertrophy frequently coexist. Stagnant residual urine and infection predispose to the formation of bladder calculi. Constipation and hemorrhoids, caused by pressure of the prostate on the rectum, are also frequently present.

**Diagnosis** The patient should be given a careful general and special examination, including rectal palpation, an estimation of the amount of residual urine, determination of the renal function, and a cystoscopic examination to ascertain the exact nature of the enlargement. The removal of an enlarged prostate when there is little or no residual urine is specifically contraindicated as a rule. The size of the prostate as felt by rectum is no indication of its obstructiveness, nor does the fact that the gland feels normal to rectal palpation rule out obstruction of the bladder neck by an enlarged median lobe, a fibrous bar, or hypertrophy of the subcervical group of tubules. The extent of the intravesical and intraurethral intrusion can only be determined by cystoscopy, cystourethrography, or suprapubic cystostomy (Plate V).

Instrumentation (catheterization, cystoscopy, urethroscopy) should, however, be undertaken very guardedly in any patient with an enlarged prostate, as in many of these men the least manipulation may precipitate

an exacerbation of infection or an attack of urinary retention. Careful physical examination, to determine the general vitality of the patient, and the estimation of renal function are important prerequisites to any contemplated instrumentation. The cystoscope is invaluable in differentiating the various types of prostatic enlargement and vesical neck obstruction, in determining the extent of damage to the bladder by back pressure, and in selecting the proper method of treatment. Injection cystography and cystourethrography are also of the greatest usefulness.

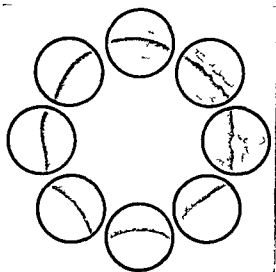


FIG. 10. Cystoscopic views of moderate enlargement of the middle and both lateral lobes.

in giving desired information. Excretory urography gives little disturbance, and may yield valuable information regarding renal damage.

**Differential Diagnosis.** The conditions which may occasion difficulty in differentiation are carcinoma of the prostate which frequently occurs simultaneously with benign hypertrophy, chronic prostatitis and rarely tuberculosis. The rectal palpation of indurated nodules in a prostate often casts the shadow of doubt on a case which is only dispelled by microscopic examination of a biopsy specimen.

**Prognosis.** The presence of residual urine which does not subside under palliative treatment is the indication that operation is necessary. The outcome without surgery in patients with residual urine and retention is gloomy—the only other alternative being a catheter life with

its notably poor life expectancy. Early operation on the properly prepared patient is, therefore, the treatment of choice in cases with residual urine, and is done much more frequently than formerly. Unless the kidneys are seriously impaired, there is rarely a fatality, and even when the kidneys and heart have been seriously affected, the mortality is relatively low, considering the advanced age and physical handicaps of most of these patients

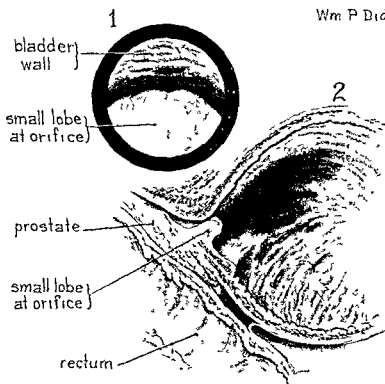


FIG 171 Slightly enlarged middle lobe (1) Cystoscopic view (2) Sagittal section showing location of lobe in relation to vesical orifice

Prostatectomy or resection, properly performed, results in the restoration of the ability to void normally. The operation cannot, of course, be expected to cure irreparable cardiovascular, renal, and vesical lesions, although by establishing good elimination, it materially benefits even these cases. However, as tersely stated by Crabtree and Prien, "The patient who delays operation until permanent bladder damage and partially destroyed kidneys are present cannot expect a perfect result,

despite adequate removal of obstructing tissue. Re education of the male in the prostate age, so that he will seek medical advice earlier, is the only solution for this distressing problem.

**Treatment** Many patients with benign hypertrophy of the prostate have no obstructive symptoms and do not require surgery. In cases with slight enlargement, slight or intermittent urinary symptoms, and

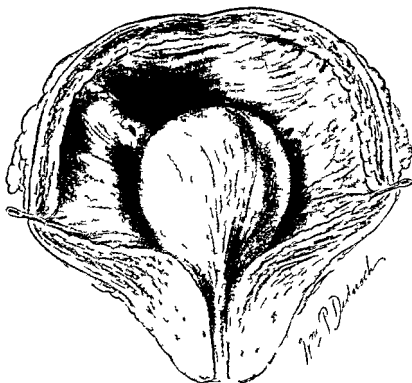


FIG. 172 Tremendous enlargement of the middle lobe accompanied by considerable hypertrophy of the lateral lobes. This type of case is best handled by prostatectomy (Specimen from collection of Dr. Legueu).

little or no residual urine, palliative treatment may first be tried. This consists of periodic prostatic massage, gentle dilatations of the urethra by sounds or the Kollmann dilator, urethrovaginal irrigations, hot rectal irrigations, hot sitz baths, and plenty of fluids. Hormonal therapy and roentgen irradiation afford symptomatic relief in some cases. Periodic observation and check up are essential in cases treated expectantly.

When residual urine is present, operation is usually required. Every patient presents his own particular problem, and the selection of the type of operation should be governed by the conditions present. In general, in small encroachments on the floor of the vesical orifice, transurethral resection is indicated; in greatly exaggerated intravesical intrusions,

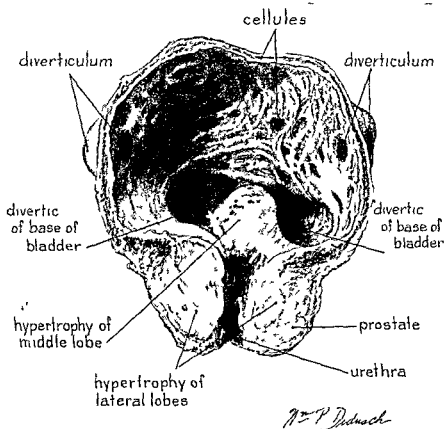


FIG. 173 Moderately enlarged middle lobe with slight enlargement and intraurethral intrusion of the lateral lobes. Hypertrophy is not yet great enough to prevent satisfactory resection (Christeller)

suprapubic prostatectomy is indicated; and in those cases in which the enlarged prostate is mainly outside the bladder, perineal prostatectomy is the operation of choice. Irrespective of the type of operation chosen, the basis of success is careful preparation of the patient.

The surgical treatment of prostatic hypertrophy, and the preoperative treatment, are considered in full under Operative Treatment of the Prostate Gland (p 880).

*Hormonal Therapy* During the past decade the possibilities of the clinical application of hormonal therapy in cases of benign prostatic hypertrophy have engaged the attention of many authoritative scientists and clinicians, both in America and Europe, and an immense literature has grown up around this subject. There have been many reports of definite clinical improvement in patients whose prostatism was not too far advanced, although most investigators state that no actual diminution in the size of the prostate is apparent.

Hormonal treatment is not a panacea. Even its most enthusiastic advocates do not claim that relief of symptoms is effected in all types of cases, or that it is to be considered a substitute for surgical relief in major benign prostatic obstructions.

A large number of chemically related and intermediate substances have been prepared synthetically, some of which have androgenic and others estrogenic properties.

Synthetic testosterone propionate is the most widely used and potent androgenic substance. It should be administered in adequate dosage at sufficiently frequent intervals. Some clinicians inject a testis tissue extract simultaneously with testosterone propionate. The androstine preparations are frequently used for this purpose—ampoule A supplying the hormone inhibin to restrain hyperaction of the anterior pituitary and ampoule B prolonging the action of the testosterone propionate. Laqueur and Van Capellen, after several years of clinical experience with the Dutch product *hombreol*, report excellent results from its use. These authors believe that prostatic hypertrophy is caused by hormonal imbalance of the estrogen androgen ratio, particularly a diminution in the male hormone and hence advocate the use of concentrated male hormone to counteract these actions. Encouraging results have also been reported from the use of androstine, a preparation which utilizes all the active principles of the testis. Ampoules A contain the water soluble product and ampoules B the lipo soluble active principles, while androstine tablets contain both extracts. Inasmuch as the mechanism of the testicular secretions is as yet imperfectly understood, there would seem to be certain advantages in employing a substance, such as androstine which utilizes all the active principles of the testis.

The published reports show a considerable difference of opinion as to the results obtained from the use of androgenic substances in the treatment of benign prostatic hyperplasia. Some writers claim definite clinical benefits, while others have observed no substantial or lasting improvement.

following their use. The majority report little or no reduction in the size of the prostate on rectal palpation or by cystoscopic examination. A few have not only observed no beneficial effects but claim that occasionally testosterone seems actually to stimulate the hyperplastic process.

The use of estrogenic substances is still in the experimental stage, but there is some reason for hoping that these may prove more efficacious in controlling benign prostatic hyperplasia than have the androgenic substances. As previously noted, Wugmeister, in 1937, expressed the view that benign hyperplasia of the prostate is due to a deficiency of the *estrone* normally present in males, and reported marked functional improvement and a decrease in the size of the prostate in 23 patients treated with large doses of estrone. Diethylstilbestrol, synthesized in 1937 by Dodds and his coworkers, and diethylstilbestrol dipropionate are considerably more potent than estrogen, and have been found to inhibit the growth of the gonads of both sexes, as well as the seminal vesicles and the prostate. A number of recent reports on the results of treatment of benign prostatic hyperplasia with these estrogenic substances claim not only marked functional improvement but actual diminution in the size of the prostate. Whether or not these results are merely temporary, or whether benign prostatic hyperplasia can be controlled by adequate maintenance doses of potent estrogenic substances remains to be seen.

To summarize, Hormonal treatment cannot at present be considered a substitute for surgical relief in major prostatic obstructions. It has proved most useful in early cases of prostatism with slight or moderate urinary frequency, nocturia and low urinary residual in the bladder. The general consensus seems to be that it relieves and ameliorates to a great extent the distressing symptoms in these cases and tends to arrest, at least temporarily, the hyperplastic process. Whether the good results will be lasting still remains to be seen.

Hormonal treatment is of interest also because of its possibilities for the patients who refuse surgery or are poor surgical risks because of advanced degenerative changes in the cardiovascular renal systems, coronary disease, or senile debility. In the latter group undoubted palliation and amelioration of symptoms has sometimes been observed.

Although there can be no doubt as to the striking clinical improvement many patients have shown from treatment with androgenic substances, most authors report that little or no reduction in the size of the prostate is demonstrable on rectal palpation or by cystoscopic examination and air cystograms. Many theories have been advanced to account for this

clinical improvement, but the mechanism is as yet obscure. Hamilton has called attention to an increased hypertrophy of the skeletal, heart, and intestinal muscles following the intensive use of testosterone, and attributes the benefit observed in prostatics to increased muscle tonus of the detrusor bladder musculature.

*Hormonal therapy with estrogenic preparations is still in the experimental stage, and only the accumulative experience of clinicians and research scientists over a longer period of time will determine its true field in the treatment of benign hypertrophy of the prostate and other conditions.* The reports to date, however, have been encouraging and definitely warrant further trial of these substances.

### *Median Bar*

Other causes of obstruction at the vesical neck, in addition to benign hypertrophy of the prostate and subcervical group of Albarran, are carcinoma (p. 844), contracture of the vesical neck, a true fibrosis resulting from chronic inflammation (p. 1065), and the true median bar with hypertrophy of the prostate gland.

**Etiology and Pathology** Alexander Randall, to whom we are indebted for much of our knowledge regarding median bar obstruction, differentiated four types of median bar formation:

- (1) An abrupt bar or dam of dense sclerotic tissue stretched across the posterior lip of the vesical orifice, due to the proliferation of connective tissue and always associated with a small sclerotic prostate.
- (2) A bar of sclerotic tissue growing upward rather than across, encroaching more upon the vesical trigone than upon the urethral surface, so that it tends to cause a transverse fold or crease in the trigonal area.
- (3) The glandular bar, resulting from the true glandular hyperplasia originating under the sphincter muscle within the prostatic capsule. Even very slight hypertrophy at this point will tend to produce a thick, broad round-edged bar causing obstruction of the vesical outlet long before a correlative hypertrophy of the lateral lobes assumes any importance. This is the most frequent type of median bar.
- (4) A glandular formation due to an isolated hypertrophy of the subcervical glands of Albarran and producing, not a bar, but a rounded lobe. Randall found difficulty in deciding whether



such formations, when discovered in the bar form, should clinically be classed as such or be grouped with prostatic hypertrophies, "which anatomically they are."

The pathological changes found in the region of the vesical neck are all dependent upon the existence of inflammation. Etiologically, they are similar to those producing stricture of the anterior urethra. The mucosa of the vesical neck is even better supplied with glands than is

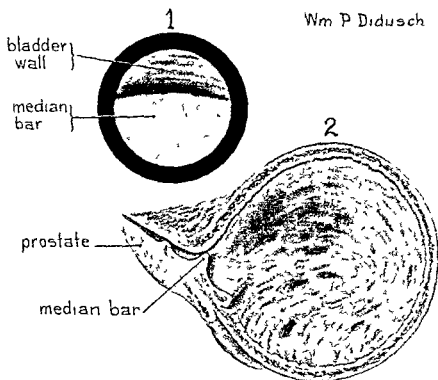


FIG. 174 Median bar obstruction. (1) Cystoscopic view of bar  
(2) Sagittal section of bladder showing obstruction by bar

that of the anterior urethra, consequently inflammation will make rapid headway in this region. Any condition which will eventually produce hypertrophy of the prostate gland may act in like manner upon the tissues of the vesical neck.

The obstructive mechanism set up by the median bar produces typical changes of back pressure: trabeculation, the formation of cellules, hypertrophy of the interureteral ridge, vesical diverticula, and involvement of the upper urinary tract with reduced renal function.

**Symptoms and Diagnosis** The clinical picture is similar to that seen in prostatic hyperplasia except that the patients are usually younger. The most common complaints are of urinary frequency, urgency, hesitancy, and a small stream—symptoms which may readily be attributed to other causes, such as prostatitis. Persistent pyuria is a common but late symptom. Rectal palpation reveals nothing suggestive.

Positive diagnosis is made by cystoscopic examination.

**Treatment** When obstruction is caused by a median bar transurethral excision of the bar with the resectoscope is the operation of choice. We have found the Kirwin resectoscope (p. 913) highly satisfactory. The preliminary measures regarded as essential to one about to undergo prostatectomy (measurement of the amount of residual urine, determination of renal function, institution of catheter drainage if necessary) are just as important as in open operation.

Secondary changes such as diverticulum and hypertrophy of the interureteral ridge, may require additional treatment.

### *Malignant Tumors of the Prostate Gland*

#### CARCINOMA

Carcinoma of the prostate, because of its frequency and its essentially fatal nature, presents the urologist with his most baffling and discouraging problem. Young's statistics (1936) reveal that a fifth of the male patients who seek relief of obstruction of the vesical neck have carcinoma of the prostate. The frequency of prostatic carcinoma in elderly men is shown by autopsy reports. Rich in 292 autopsies on men over 50 years of age at The Johns Hopkins Hospital found carcinoma of the prostate in 41 cases (14 per cent), in 68 per cent of which the tumor had not been discovered because it was too small to produce symptoms. Robert A. Moore (1935) found prostatic carcinoma in 21 per cent of 252 subjects between 41 and 90 years of age examined by him. In only a small percentage of cases is diagnosis made early enough to offer a chance of success by any known method of treatment. Suffering may, however, be considerably lessened and life prolonged for varying periods (2 to 7 years) by the various methods of treatment at the urologist's disposal.

**Etiology** The etiology of carcinoma of the prostate is unknown. Chronic hypertrophy is given by Ewing as the chief condition predisposing to prostatic cancer. Moore found carcinoma of the prostate to be intimately associated with senile atrophy and believes that in the vast majority of cases prostatic cancer results from stimulation and

autonomous proliferation of epithelium which has already undergone atrophy Hryntschaik believes that there is an etiological connection between carcinomatous and regenerative proliferations of the prostatic tissues Huggins of Chicago, has recently suggested an entirely new concept namely that there is a relationship of the androgenic hormone to carcinoma of the prostate (see p 858)

**Pathology Associated Pathology Metastasis** A large percentage of cases of carcinoma of the prostate are associated with benign hypertrophy Of Wilson and McGrath's 72 cases 51 showed marked glandular hypertrophy, as was evidenced microscopically by papilliferous projections into the acini, 30 showed definite muscular atrophy, 61 increase in the fibrous stroma while in 10 cases (13 per cent) there was no evidence of associated hypertrophy Whether the hypertrophy in these cases was primary and

TABLE V

AGE OF GROUP	PROSTATES EXAMINED	PER CENT SHOWING CARCINOMA	PER CENT SHOWING BENIGN ENLARGEMENT	PER CENT OF CARCINOMAS WHICH AROSE IN A PROSTATE WITH BENIGN ENLARGEMENT	PER CENT OF BENIGN ENLARGEMENT WHICH ALSO SHOWED CARCINOMA
31-40	28	0%	4% (1)	0%	0%
41-50	23	17% (4)	30% (7)	25%	14%
51-60	65	14% (9)	37% (24)	50%	21%
61-70	77	23% (18)	67% (52)	66%	23%
71-80	63	21% (13)	68% (43)	46%	14%
81-90	24	29% ( )	75% (18)	71%	27%

the carcinoma implanted thereon could not be determined though in many microscopic sections the apparent transition by almost imperceptible variations from simple hyperplasia to undoubted carcinoma was observed In 468 prostatectomy specimens removed for benign hypertrophy and studied by the same authors, there were found 73 carcinomas (15.5 per cent)

In his very complete study of 280 prostates from men between the ages of 31 and 90 years Robert A Moore found the occurrence of carcinoma and benign enlargement to be as shown in Table V It is evident therefore that the possibility of carcinoma must be kept in mind in every patient with prostatic hypertrophy

The original conclusion of Geraghty and Boyd that prostatic carcinoma begins in over 75 per cent of cases in the posterior lobe (the particular portion of the gland which does not participate in benign adenomatous hypertrophy), although repeatedly challenged is borne out

by the more recent studies of Moore (1934) and of Barringer (1936) In the remaining 25 per cent of cases the origin of the cancer may be in the lateral, anterior, or median lobe In the early stages, carcinoma may appear in a single focus or in multiple foci Barringer is of the opinion that adenocarcinoma is frequently primary in the subcervical group of glands and later extends into the substance of the prostate proper or into the bladder

Prostatic carcinoma is, as a rule, insidious and slow growing, though highly malignant, and in some cases may remain confined to the prostate and periprostatic region for long periods Only 10 to 20 per cent are radio sensitive (Barringer)

In many cases by the time the growth has become sufficiently advanced to be clinically diagnosed, it has extended beyond the posterior lobe into the lateral and median lobes and upward to the base of the prostate There it may penetrate the prostatic capsule and involve the seminal vesicles Only when the growth has passed the upper edge of the intravesicular fascia is it able to invade the rectum, which is protected in the region of the prostate itself by the fascia of Denonvilliers Invasion of the vesicles and of the bladder are usually late manifestations According to Barringer, the earliest direct extension of the disease is in the direction of the subcervical group of tubules, and in his material "primary or secondary involvement of this group was more frequent than the time-honored extension to the seminal vesicles"

The prostate gland is richly supplied with lymphatics, through which carcinoma extends to the pelvic nodes or, by the perirectal plexus, to the abdominal nodes Dissemination through the blood stream may occur early, and distant metastases, particularly in the bones, are often detected before the occurrence of local symptoms The small prostatic tumor often disseminates widely

The high frequency of skeletal metastases of carcinoma of the prostate, and the predilection for the pelvis and the lumbar vertebrae have been noted by practically all observers Graves and Militzer, in a clinical review of 81 cases of carcinoma of the prostate found x ray evidence of metastasis to the pelvis and sacrum in 85 per cent and to the lumbar vertebrae in 59 per cent, while the femora was involved in only 35 per cent and the dorsal spine in 23 per cent Metastases to the bones have been commonly accepted as hematogenous in origin While accepting this origin so far as central bone metastases are concerned Graves Warren, and Harris (1936), from studies on autopsy and operative mate

rial and clinical observation of patients, concluded that the chief factors in the marked preponderance of pelvic and lower vertebral involvement are the wide distribution of the periprostatic nerves and the conduction of tumor along the perineural lymphatics into intimate contact with bone (bony pelvis, sacrum, lumbar spine) The perineural lymphatic dissemination of the tumor may be either by continuity or, rarely, through

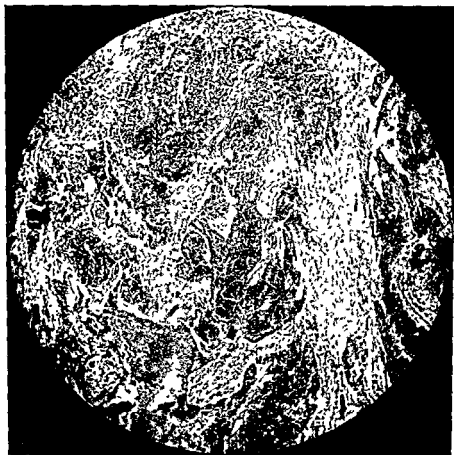


FIG. 175 Carcinoma of the prostate Scirrhus type with invasion of epithelial cell strands.  
Photomicrograph  $\times 80$

embolism The pain which is a relatively early symptom of prostatic carcinoma is clinical evidence, these investigators believe, of the existence of this perineural lymphatic involvement, which they found to be a constant feature in practically all the cases of carcinoma of the prostate studied by them

Adenocarcinoma is the commonest type of prostatic cancer. A great

variety of arrangements in the adenocarcinomatous tissues has been described. The acini of the tumor may be small, numerous and crowded together, with compressed cylindrical cells of the aberrant type, or they may be large and loosely filled with aberrant cells containing metachromatic nuclei. In most instances cancer cells infiltrating the stroma can be readily demonstrated. In medullary carcinoma the cells are relatively

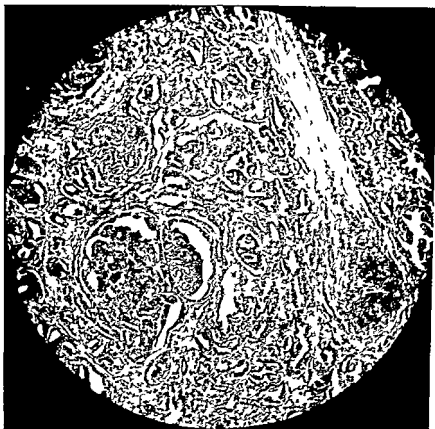


FIG. 176 Carcinoma of the prostate gland. Photomicrograph showing adenocarcinomatous structure with large and small alveolar formation.  $\times 80$

large and polygonal in shape with swollen chromatophilic nuclei and are supported by a delicate capillovascular network. The scirrhous type shows infiltrating lines or groups of aberrant cells with densely staining nuclei scattered through a superabundant stroma—the stroma itself being frequently infiltrated with small cells containing densely staining nuclei and being apparently proliferating.

A striking morphologic peculiarity of carcinoma of the prostate gland that has been emphasized by most authors is this diversity of its forms. In the same case in different portions the carcinomatous proliferation may be found at one time as an adenocarcinoma and again as a scirrhous, a medullary or a squamous-cell carcinoma. Hryntschak (1936) advanced the hypothesis based on his histological examination of 310

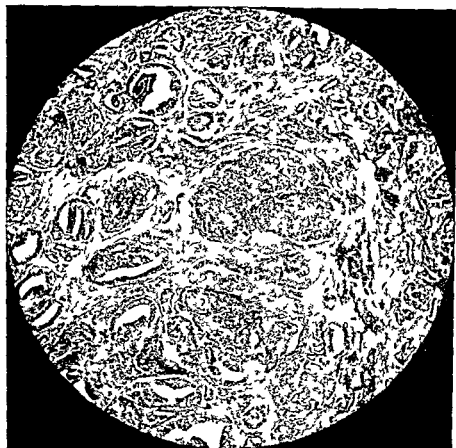


FIG. 177 Adenocarcinoma of the prostate gland with some tendency to the formation of solid masses of cells. Photomicrograph  $\times 80$ .

operative specimens that carcinoma develops from multiple regeneration centers, the malignant proliferations each issuing from a separate regeneration focus and presenting structural diversities dependent on the different kinds or stages of regeneration. These individual carcinomatous foci then grow toward each other and fuse in the end, presenting the well known picture of carcinoma of the prostate gland.

The hard, tense structure of prostatic carcinoma imparts a gritty sensation to the knife, as if one were sectioning cartilage. The finer details of the cut surface vary somewhat, irregularly interlacing bands of varying sizes being seen, with small, isolated grayish yellow masses scattered here and there. The interlacing bands are fibrous in character, and the yellowish areas accumulations of cancer cells. This appearance is not present in fibrous prostatitis, in which the epithelial element frequently disappears and in which the surface is much more smooth and homogenous than in carcinoma. Where carcinoma is infiltrating in character, fine yellowish lines can frequently be seen microscopically. Usually one can be moderately certain of the cancerous nature of the tissue upon gross inspection alone. When the surgeon's knife, in making capsular incision, cuts through tense tissue which does not bulge, the edges of which are firm and ridged, suspicion should at once be aroused.

**Symptoms of Prostatic Carcinoma** The symptoms of prostatic carcinoma are in no way characteristic and are not easily differentiated from those of benign hypertrophy, which is often present at the same time. Frequency of urination, difficulty, and nocturia are the most common early symptoms, and are usually due to obstruction caused by an associated hyperplasia. Advanced prostatic cancer may, however, be present without urinary symptoms. Retention and terminal hematuria are later manifestations, and are frequently the reasons for the patient seeking medical advice. Pain—referred to the sacroiliac region, penis, rectum, perineum, thighs, inguinal regions, or suprapubic area—is a predominant and relatively early symptom in about 65 per cent of the cases and may be due to metastases to the bones. Loss of weight and strength, and constipation are significant but late symptoms.

**Diagnosis** Carcinoma of the prostate has usually existed for a long period by the time it is recognized. In advanced cases, the diagnosis is made without difficulty on the history, rectal findings, and microscopic examination of a biopsy specimen removed by means of a biopsy instrument. The typical prostatic carcinoma is unyielding, board like, tense, and irregular in contour. The prostate is fixed in position. Evidence of the fixed gland may be seen on cysto-urethroscopic examination. Extensive induration, with fixation of the prostate and adhesions, is strongly suggestive of carcinoma even in the absence of the usual stony hardness. The entire gland may be enlarged, hard, and fixed, but usually the growth is in the form of a nodule or hardened area in the posterior lobe, where it is readily palpable by rectum.



In early cases, in the soft (medullary) type of carcinoma, and in carcinoma superimposed upon a benign hyperplasia, diagnosis may be very difficult. A single, small nodule may easily escape notice, especially when masked by edematous prostatic tissue. The chief obstacle to the detection of early cases, however, is the absence of symptoms unless there is also present some degree of benign hyperplasia. The greatest hope of early recognition, therefore, lies in the routine medical check up which, in all men over 45 years of age, should always include a careful rectal examination. In the past, over 95 per cent of cases of prostatic cancer have been beyond hope of operative cure when first seen. Of 351 consecutive cases of prostatic carcinoma in Barringer's series only 16 cases (4.5 per cent) were confined to the prostate and periprostatic area. Responsibility for the early recognition of prostatic carcinoma falls primarily on the general practitioner. It is so important for malignancy of the prostate to be discovered early that, in our opinion, any physician who fails to make a rectal examination of his male patients over 45 years of age is guilty of the grossest neglect. It is also important that a painstaking search for carcinoma of the prostate be made in all cases of frequency, dysuria, and retention in men of cancer age.

Cystoscopy and cysto-urethrography will give valuable information regarding the degree of intraurethral and intravesical intrusion in the 25 per cent or more of cases that originate in portions of the prostate other than the posterior lobe, and in those cases that begin in the posterior lobe and have progressed to an extent sufficient to produce obstruction of the bladder neck.

If rectal palpation reveals a suspicious nodule or indurated area in the prostate, a specimen or specimens of tissue should be removed through the perineum by means of a biopsy instrument and submitted to serial section. Aspiration biopsy successfully establishes the diagnosis in most cases but unless positive, should not be considered diagnostic. Negative findings cannot always be accepted as proof positive of the absence of malignancy. In suspected early, small tumors, and in cases in which the diagnosis remains in doubt, surgical exposure of the prostate through the perineum, with the excision of a piece of tissue from the suspected area, is warranted.

*The Lowsley biopsy instrument*, which we have found very satisfactory, is illustrated in figures 178 to 181.

A careful search for metastases, particularly in the bones, is essential in all cases of prostatic carcinoma. Skeletal metastases from carcinoma

of the prostate must be differentiated from osteitis deformans (Paget's disease of bone), which is also a disease of later adult life. The differential diagnosis is dependent upon x ray examination and the study of serum phosphatase activity. In far advanced osteitis deformans there will be found extremely high levels of *both* serum "acid" and serum "alkaline" phosphatases, whereas in prostatic carcinoma with bony metastases only

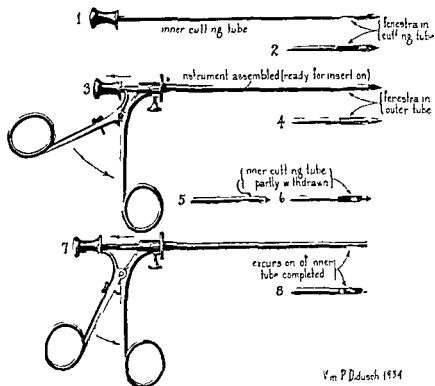


FIG 178 Lowsley biopsy instrument (1) The obturator of the instrument with inner cutting tube containing a fenestra studded with saw teeth (2) Shows the arrangement of the teeth in the fenestra (3) The assembled instrument (4) Shows the arrangement of the inner and outer tubes when the fenestra is closed (5, 6) Views of the inner cutting tube partly withdrawn (7, 8) Complete closure of fenestra.

the serum "acid" phosphatase will be *markedly* elevated. Regarding the x ray findings, DeVries has pointed out the following important points in the differential diagnosis (1) As to distribution, although the spine, pelvis, and long bones may be affected by either disease, a skull lesion will most likely be Paget's disease, a rib lesion most likely carcinoma (2) Regarding local appearances, thickening, increase of coarse trabecu

lations, bowing and deforming, increased cortical density, and decrease of the marrow space are the important findings in Paget's disease, whereas absence of these signs, with spotty areas of increased density, decreased density, or both, are the significant findings in bone metastases from carcinoma of the prostate. This mottled, spotty appearance probably represents minute areas of tumor cells surrounded by new bone.

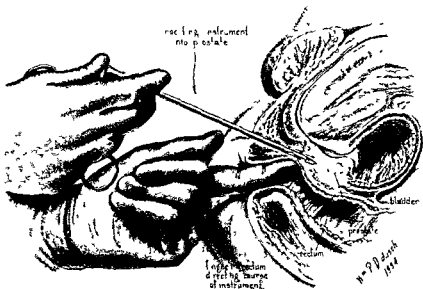


FIG 179 Lowsley biopsy instrument. Sagittal view of the insertion of the instrument into the prostate and the anatomical arrangements. When the instrument has reached the suspected area in the prostate the obturator is turned so that the two fenestrae coincide. Pressure is made by the finger in the rectum in such a manner as to cause the suspected tissue to penetrate the fenestra.

#### *Serum "Acid" Phosphatase and Its Relation to Prostatic Carcinoma*

A relatively new and valuable diagnostic method in carcinoma of the prostate with skeletal metastasis is the study of serum "acid" phosphatase activity.

In 1935, it was observed by Kutscher and Wolbergs that normal adult prostatic tissue contains a very high concentration of a phosphatase which manifests its optimum activity between pH 4.5 and 6.0. This enzyme, which is apparently elaborated by the prostatic epithelium, is present in small amounts in human prostate glands in infancy and childhood, and is increased during puberty to the high levels found in the adult. A technic

for the microscopic demonstration of this substance in tissues was published by Gomori in 1939. The enzyme is also found in the blood serum of the adult human. It can be quantitatively determined, both in the tissues and in the blood serum, by the King and Armstrong method. The blood serum of normal adult humans contains 4.0 or less King and Armstrong units of the enzyme per 100 cc. of blood.

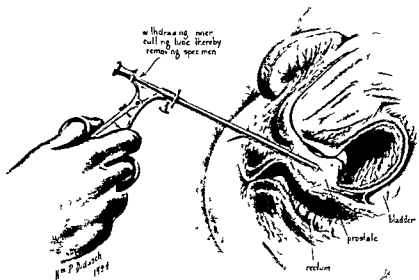


FIG. 180 Lowsley biopsy instrument. Shows withdrawal of the inner cutting tube holding the excised tissue, also the cavity in the prostate whence the tissue was removed.

E. B. Gutman, A. B. Gutman, and their associates have shown that this enzyme is present in large amounts in carcinomatous prostatic tissue, both at the primary site and at metastatic sites, and that most patients with carcinoma of the prostate, with skeletal metastases, have markedly elevated levels of this substance in their blood sera.

It has also been shown that *marked* increase in serum "acid" phosphatase is present *only* in prostatic carcinoma with metastasis to bone and in certain cases of far-advanced osteitis deformans (Paget's disease of bone). In the latter disease, however, extremely high levels of serum "alkaline" phosphatase (which manifests its maximum activity at a pH of 6.5 to 9.0) are also found, and the x-ray findings, as previously noted, are quite characteristic. Moderate elevations in serum "alkaline" phosphatase

are occasionally found in cases of disseminated carcinoma of the prostate, but never the high levels found in far advanced osteitis deformans. In

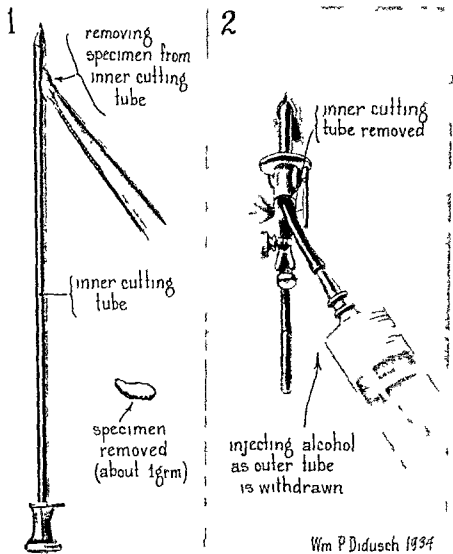


FIG 181 Lowsley biopsy instrument. (1) Removal of the specimen from the inner cutting tube. About 1 to 1.5 gm of tissue is usually removed at each effort. (2) After the inner cutting tube has been removed a small catheter may be introduced through the outer sheath and alcohol injected through this as the sheath is withdrawn (or an electrode may be introduced) to prevent distribution and implantation of cancer cells.

pathological conditions of the prostate other than carcinoma metastasizing to bone (including cases of carcinoma without skeletal metastasis), and in non prostatic diseases (including various types of cancer, with and

without bony involvement), elevated levels of serum "acid" phosphatase have been found rarely

Although prostatic carcinoma with skeletal metastasis may be present without elevation of serum "acid" phosphatase, in all cases having 10 or more King and Armstrong units per 100 cc of blood serum, prostatic carcinoma with skeletal metastasis has been present (Huggins, Scott, and Hodges). Most of this increase is derived from the malignant prostatic tissue, "which is usually not embryonic but of an adult type"

As pointed out by Curtis (1943), the study of serum "acid" phosphatase in carcinoma of the prostate has already proved its clinical usefulness in the following respects: "(1) as a means of definitely establishing the diagnosis in cases of suspected carcinoma of the prostate with bony metastases, (2) in the selection of therapy in prostatic carcinoma—in the absence of metastases warrants an attempt at total eradication of the disease by total perineal prostatectomy, whereas the presence of metastases indicates the employment of hormonal therapy (castration, estrogen administration) and the relief of urinary obstruction (transurethral resection), (3) in determining whether skeletal metastases are of prostatic or non prostatic origin in cases where such metastases are present but the site of the primary lesion is unknown, (4) in differentiating between disseminated prostatic carcinoma and early or moderately advanced osteitis deformans, (5) as an index to recurrence following prostatectomy or to the progression of metastases, and hence of value in guiding and evaluating the therapy employed"

**Prognosis** The prognosis of carcinoma of the prostate in the past has been cheerless in the extreme. The subject of metastasis is of paramount importance in prognosis, as well as in the choice and limitation of treatment. In cases in which the growth has not yet invaded the tissues beyond the reach of excision, total or partial prostatectomy with radiation may yield a fair percentage of cures estimated upon a 3 to 5 years' basis, and prolongations of life for considerably longer periods are not uncommon. Complete surgical removal is not often possible, however, by the time the patient comes under treatment. The high early incidence of pelvic lymphadenopathy, capsular infiltration and invasion of the contiguous structures, precludes the successful surgical treatment of the disease in the majority of cases. Improvement in prognosis is dependent on an increase in the number of early diagnoses with radical removal. Despite the inevitable fatality of the disease, relief of suffering and postponement of death, sometimes for many years is possible.

**Treatment** There is no standard treatment of carcinoma of the prostate. Several methods are available: (1) surgery (total perineal prostatectomy, subtotal perineal prostatectomy, conservative perineal or suprapubic prostatectomy, transurethral resection), (2) radiotherapy (radium, deep x ray), (3) hormonal therapy (castration, estrogen administration, irradiation of the testicles), (4) combinations of these methods.

*Total perineal prostatectomy*—that is removal of the prostate gland and its capsule, the seminal vesicles, and the prostatic urethra—at present offers the only hope of cure and this operation is applicable only when the growth, as ascertained by rectal and cystoscopic examinations, is confined to the prostate, its capsule, and the bases of the seminal vesicles, and has not extended into the membranous urethra. The age and general condition of the patient must also be taken into account. In the past very few cases have been diagnosed at a stage when cure by complete removal has been possible—that is before the growth has extended beyond the prostate gland itself—but as the medical profession in general becomes more alert in searching for cancer of the prostate, it is to be expected that increasing numbers of cases will be recognized at a stage when hope for a cure by total prostatectomy can still be entertained.

Competent opinion differs considerably as to whether the radical operation should be done in the presence of demonstrable skeletal metastasis. Some urologists believe that it should not be done, while others feel that if the tumor is relatively small, the patient's general condition good, and metastases not too widespread, removal of the local growth may retard the metastatic process, lessen the patient's discomfort, and prolong his life.

It is our opinion that men with early or moderately advanced prostatic carcinoma should have the benefit of the radical operation whenever possible. We feel that the reluctance of many surgeons to undertake total prostatectomy has been largely due to the overstressing of its difficulty and risk to the patient, as well as to the widespread impression that urinary incontinence is the almost inevitable result of the operation. When performed on carefully selected patients, and by a surgeon skilled in perineal surgery, neither the operative mortality nor the postoperative complications should be any greater than in prostatectomy for benign hypertrophy. Moreover, damage to the external sphincter—the cause of postoperative incontinence—can be largely avoided by the recent improvements in technical details, especially in the methods of placing sutures to complete the anastomosis between the membranous urethra and the neck of the bladder (Total Perineal Prostatectomy, p 922).

In the type of case most frequently seen by the urologist, in which radical cure is precluded by extension of the local tumor beyond the prostate and the periprostatic region, or by the extent of the metastatic involvement, treatment can only be palliative and directed toward the relief of urinary obstruction and pain. There are three methods of relieving urinary obstruction: (1) by transurethral resection, (2) by conservative perineal or suprapubic prostatectomy, and (3) by suprapubic cystostomy. In far advanced cases, where resection or prostatectomy is contraindicated by the late stage of the disease and the poor condition of the patient, and where urinary obstruction is marked, *suprapubic cystostomy* may be the operation of choice. *Transurethral resection* is widely employed for the removal of the obstructing carcinomatous tissue, and has proved a decided boon to many patients. In some cases, however, the electrical current so seriously affects the devitalized malignant tissue that necrosis and persistent infection result. There is also considerable evidence that resection of part of a carcinomatous prostate speeds up growth of the remaining malignant tissue, often necessitating a secondary operation within a short period of time. We are therefore inclined to favor *conservative perineal prostatectomy* in the case of larger neoplasms, especially those associated with a considerable degree of benign hypertrophy, when large amounts of tissue must be removed to relieve the obstruction. Radon seeds can then be implanted through the perineal incision under direct vision if desired.

When the disease is too extensive for radical removal, but there are few or no symptoms of urinary obstruction, many urologists prefer to treat the patient by a combination of (1) interstitial irradiation by means of radium needles or radon seeds, or surface applications of radium, and (2) deep x ray therapy directed not only to the prostate but also to known or probable metastatic sites (see Radium and Roentgen Therapy in Urology, Prostate Gland, p. 1747). By the combined use of *radium and deep x ray*, the local growth can often be controlled for some time. The use of radium or deep x ray, or both, following resection or prostatectomy also has a tendency to postpone the recurrence of the growth.

*Castration*, the newest method of treatment, has effected a significant improvement in the clinical condition of many patients with advanced or metastatic carcinoma of the prostate. This treatment was originally suggested by Dr. Charles Huggins and his associates, who in 1941 presented evidence for their concept that "carcinoma of the prostate often is composed of epithelial cells of a mature type which, in common with all



other types of adult prostatic epithelium, is responsive to depression of the level of androgenic hormones in the organism" (Huggins, Scott, and Hodges) Eliminating the gonadal androgens by castration, or neutralizing their activity by estrogen therapy, they found, decreased the activity of this neoplasm, whereas injection of androgen increased it In 1940-1941 they castrated 21 patients with far advanced or metastatic carcinoma of the prostate Of these, 4 died within 8 months and 2 were followed for only brief periods, the remaining 15 showed appreciable clinical improvement as evidenced by marked diminution of pain, increase in body weight, appetite, and red blood cell and hemoglobin values, shrinkage of the primary lesion on rectal and cystoscopic examination, and stabilization or regression of bony metastases in the roentgenograms

Subsequent to the publications of Huggins and his coworkers there have appeared in the literature other reports showing equally good results from castration

In 1941, Dr Arbor D Munger reported his experiences in the treatment of advanced carcinoma of the prostate with *supervoltage irradiation of the testicles* In 11 cases of prostatic carcinoma seen between 1933 and 1938, in which the patients had transurethral resection of the prostate with planned x ray therapy, "each testicle was given directly an equivalent of 500 r supervoltage therapy, over and above the necessary back scatter which accompanies irradiation treatment applied to adjacent areas in these cases' Eight of these patients were living at the time of the report, the longest time of survival being 7 years, the shortest 3 years—somewhat better results, this author states, than were obtained in parallel cases treated by resection and x ray exclusive of the testicular application

Recently there have been reported encouraging results following the *administration of the female sex hormone* (instead of castration) for the purpose of inactivating the gonadal androgens Estrogenic substances such as stilbestrol or diethylstilbestrol are capable of producing all the physiological effects of natural estrogen They are sometimes administered *after* castration to offset undesirable by effects of the operation, such as hot flushes Histological studies of the effects of estrogen administration have shown that definite regressive changes in the nuclei and cytoplasm of the tumor cells occur (Schenken, *et al*, Heckel and Kretschmer) This form of therapy therefore appears to have a very definite place in the treatment of prostatic carcinoma particularly in those patients who refuse castration or who are considered too poor operative

risks. The estrogenic substances have been given both orally and intramuscularly, in doses varying from 1 mgm weekly to 3 mgm daily. Since too high dosage produces gastric irritation and transient gynecomastia, and since the point at which these by-effects manifest themselves varies considerably in different patients, it is necessary to fit the dosage to the patient's individual tolerance. The only permanent organic damage that has been noted as a result of estrogen therapy in these cases is genital atrophy, which is rather frequent.

At the Brady Foundation, in the New York Hospital, castration has been done as a supplemental procedure in numerous cases of advanced and metastatic carcinoma of the prostate since July, 1941, and it is our opinion that the claims of Huggins and his coworkers as to the beneficial results of this procedure upon the clinical condition of the patient in many cases are in no way exaggerated. Usually a period of two weeks or more is allowed to transpire following transurethral resection or prostatectomy before orchidectomy is performed (see *Orchidectomy for Prostatic Carcinoma*, p 498). A very detailed report of 27 cases thus treated between July, 1941 and June, 1942 has recently been published by Lt. Comm. Mark S. Curtis in the *United States Naval Medical Bulletin*.

It must be emphasized that neither castration nor estrogen therapy cures the cancer; it should therefore, supplement—not supplant—other indicated surgical procedures. Complete surgical removal still remains the ideal treatment of prostatic carcinoma.

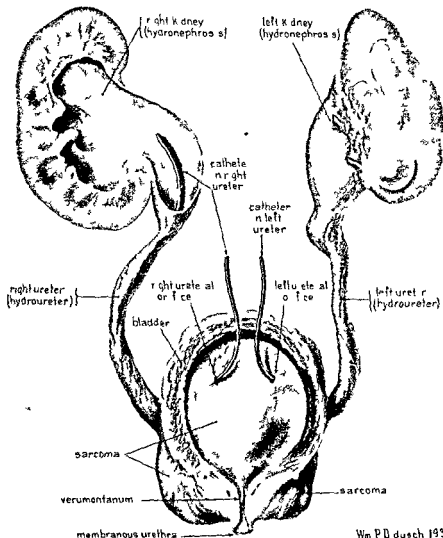
#### SARCOMA

**Incidence.** Sarcoma of the prostate gland is a rare disease. A review of the literature by Lowsley and Kimball, in 1934 disclosed only 131 reported cases in which the diagnosis was undisputed to which was added a personal case of the authors (Figs 182 to 184). Stirling and Ash (1939) added 45 cases, bringing the total to 177, and several others have been reported since.

Although sarcoma is chiefly a disease of youth, an analysis of the 132 cases reviewed by Lowsley and Kimball showed that sarcoma of the prostate is common to all ages. Our own patient was 64 years old and 22 others were over 63 years of age. Thirty-five were under 22 years.

**Etiology.** The etiology is unknown. In some cases the extent of the growth, when discovered in the first few months of life, suggests a congenital factor.

**Pathology.** On the basis of cell morphology, at least 20 different types



Wm P Dusch 1931

FIG 182 Sarcoma of the prostate (authors case) Shows the bladder opened in the anterior midline exposing the tremendous sarcomatous growth which almost completely fills the bladder. The ureteral orifices can be seen on the surface of the tumor mass. Both ureters although showing evidence of back pressure are patent. The right kidney (sectional view) is markedly hydronephrotic. The left kidney is also hydronephrotic and shows cyst formations on its surface. The high insertion of the ureters is evident and below on either side is seen the lower portion of the sarcomatous growth. The musculature of the bladder wall is greatly hypertrophied and all evidence of the trigone is obliterated.

of prostatic sarcoma have been reported spindle-cell, round cell, alveolar, medullary, lymphosarcoma fibrosarcoma myxosarcoma, adenosarcoma, angiosarcoma, rhabdomyosarcoma chondrosarcoma leiomyosarcoma

The round cell and spindle-cell varieties are reportedly the most common, but many modern writers feel that most of the tumors that have been reported as round cell sarcomas are, in reality, undifferentiated small-cell carcinomas. Stirling and Ash state "We are convinced that if a critical

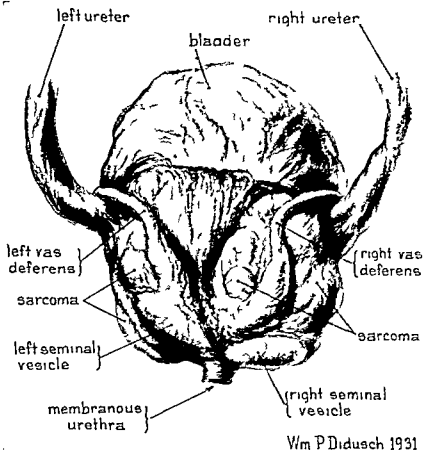
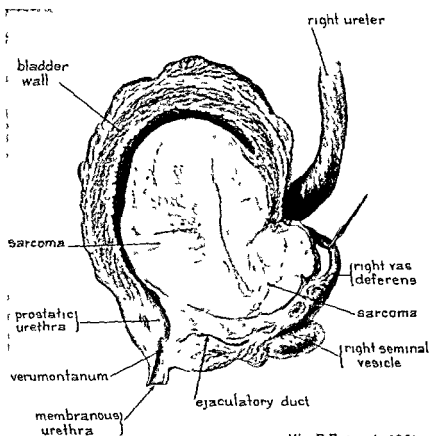


FIG 183 Sarcoma of the prostate authors case. Posterior view of postmortem specimen showing the sarcomatous growth, hydro-ureters, vasa deferentia, and the displaced seminal vesicles. Note the high insertion of the ureters.

study of the material from the reported cases could be made that some at least, of those diagnosed as spindle and round-cell sarcomas would prove to be of muscle origin."

A simpler pathological classification of prostatic sarcomas based on their tissue origin, has been proposed by Stevens and Barringer. They suggest three groups: (1) myosarcoma (leiomyosarcoma and rhabdomyosarcoma), taking origin from the musculature of the prostate; (2) lympho-

sarcoma, arising from lymph tissue in the prostate (formerly a disputed entity, but now generally recognized), sarcoma of undetermined origin—spindle-cell, round-cell, and giant-cell sarcomas, fibrosarcoma, and myxosarcoma. For clinical reasons they add a fourth group—anaplastic



Wm P Diduech 1931

FIG. 184 Sarcoma of the prostate, authors' case. Postmortem specimen. Sectional view, showing right side of specimen, with the growth almost filling the bladder. There is marked hypertrophy of the muscles of the bladder wall, dilatation of the ureter, and great displacement of the seminal vesicle.

carcinoma, which has features resembling sarcoma and is often mistaken, microscopically, for lymphosarcoma.

Dr. Robert W. Hunt thoroughly reviewed the literature on rhabdomyosarcoma of the prostate in 1942 and found reports of only 18 cases, to which he added a case in a 2½-year-old boy seen in 1937 at the Brady Foundation, in the New York Hospital. He states that, although one can never prove the origin of these tumors, it seems reasonable to believe that they arise from the normally present striated muscle elements in the

anterior part of the prostate—in the region of the internal sphincter and adjacent area of the trigone.

Prostatic sarcomas usually grow with great rapidity and attain large size, early infiltrating the bladder, seminal vesicles, and rectum. Growth of the tumor backward and upward beneath the base of the bladder pushes the bladder upward and forward, causing obstruction of the ureteral orifices, vesical orifice, and urethra, with resultant partial or complete urinary retention. Growth of the tumor toward the perineum

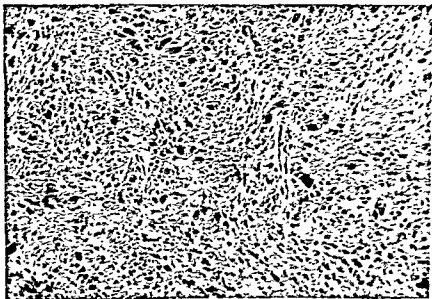


FIG. 185. Sarcoma of the prostate. Photomicrograph of an area in which many of the cells are hyperchromatic and anaplastic.

causes projection of the perineum and prolapse of the rectum, with obstruction to defecation and urination.

Regional extension was present in about 75 per cent of the reported cases. Metastases to the neighboring lymph nodes, kidneys, lungs, liver, and bones occur fairly early, both by way of the lymphatics and the blood stream. Both regional extension and metastases are most marked in the first decade, and are most frequent from the round-cell and spindle-cell sarcomas, which are the most malignant types.

**Symptoms and Diagnosis.** The early symptoms usually are dysuria and frequency. Later there are pain, which may be intense, and symptoms of obstruction of urination or defecation, or of both. The pain may be referred along the course of the sciatic nerve, or may extend over

the entire abdomen, or may occur in crises in the region of the anus and perineum. It is due to retention of urine or to extension of the growth into the retrovesical space.

Early diagnosis is essential. The diagnosis is based on the history, rectal palpation and needle biopsy, and cystoscopy. The consistency of the tumor to rectal palpation varies. In young patients, the tumors are usually larger, softer, of more uniform consistency, and have an elastic, "balloon like" feel, hence the condition has often been confused with prostatic abscess. In older patients, the growths may be firm, smooth, and circumscribed, often simulating benign hypertrophy, or they may be indurated and nodular, when they must be differentiated from carcinoma or tuberculosis. Needle biopsy will establish the diagnosis. Cystoscopy may show nodular changes affecting the urethral contour, and forward displacement of the bladder, with marked reduction of its capacity.

**Treatment and Prognosis** The prognosis is bad regardless of the type of treatment instituted, only a rare case being controlled for more than a few years by the present methods. Due to the rapid onset and course of the disease, and the fact that the tumors have invariably extended beyond the prostate when first diagnosed, surgery has consistently proved unsuccessful. The best results to date have been achieved through the use of deep x ray therapy in combination with radium applied per rectum, intraurethrally, and intravesically, but here too the benefits have almost always been but temporary. At present, the treatment of most prostatic sarcomas is directed toward the relief of urinary obstruction by means of a permanent suprapubic tube, plus radium and deep x ray therapy of the tumor.

Radiotherapy, however, appears to be definitely contraindicated in prostatic rhabdomyosarcomas since these radioresistant growths are not only not benefited, but at times appear even to be stimulated by irradiation. Hunt believes that, at present, early radical surgery (prostatectomy and total cystectomy, with transplantation of the ureters to the bowel) offers the best, if not the only, chance of a successful outcome since these tumors remain localized to the prostate and bladder for relatively long periods and seldom metastasize to distant organs. Operation, however, must be done before the growth has progressed to a stage where it has resulted in dilatation and infection of the upper urinary tract.

The only hope of a better prognosis in sarcoma of the prostate lies in an earlier diagnosis, which might be accomplished if all young males with disturbances of urination were subjected to rectal palpation, and if needle biopsy were performed on all palpable prostatic nodes.

*Calculus of the Prostate Gland*

**Incidence** Prostatic calculi which formerly were believed to be rare are now known to occur with relative frequency. The fact that such stones have been discovered more often in recent years is undoubtedly due to the more frequent use of roentgenograms. Many of these stones give no symptoms and are only discovered accidentally in the course of a routine examination or during operation for some other pathological condition in the prostate or at autopsy. In a study of over 250 prostates from subjects of all ages obtained in routine necropsies at Bellevue Hospital (New York) Lowsley found one or more prostatic calculi in approximately one fifth of the glands.

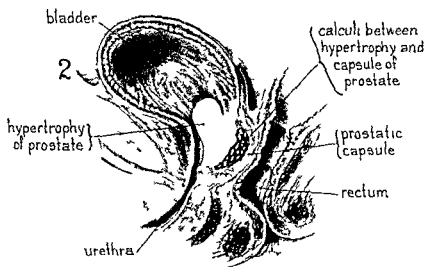
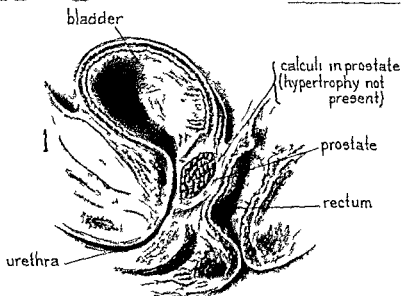
Prostatic calculi were recognized as early as 1687 by Donatus. The first accurate description of these stones was given by Pohl in 1737. In 1918 Kretschmer exhaustively reviewed the literature and reported a total of 173 cases including 8 from his own practice. In 1927 he reported 76 personally observed cases ascribing this great increase in frequency to routine roentgenograms. Young (1934) stated that 305 cases had been reported and added 100 additional cases from his own service. Lowsley and Hawes (1938) reported 23 cases.

**Etiology** Distinction must be made between (1) endogenous or true prostatic calculi namely concretions formed within the prostatic substance and (2) exogenous or false calculi which are urinary stones that have lodged in the prostatic urethra or have formed primarily from urinary sediments in a communicating pouch.

The nucleus of a true prostatic calculus is composed of organic material of an albuminoid nature but not a pure protein. It may consist of corpora amylacea, a blood clot, epithelial detritus, a clump of bacteria or necrotic tissue resulting from an abscess. The inorganic element forms the laminated layers about the nucleus and is composed of inorganic salts such as calcium phosphate, magnesium phosphate, amino magnesium phosphates, potassium phosphate, calcium carbonate and calcium oxalate. It has been pointed out (Kretschmer) that endogenous prostatic calculi can be differentiated from exogenous stones by their chemical composition, the nuclei of the latter being composed of urates and earthy phosphates. The differentiation between endogenous and exogenous calculi must rest upon the chemical examination of their nuclei for exogenous stones may have an outer covering similar in composition to that of true calculi.

The exact etiology of true prostatic calculi remains undetermined.





Wm. P. D. Busch 1932

FIG 186 Prostatic calculi (1) Sagittal section showing multiple calculi embedded in a prostate in which there is no hypertrophy. The capsule of the prostate is thinned out and compressed by the stones. (2) Multiple calculi in a hypertrophied prostate. The calculi are situated between the hypertrophied area and the prostatic capsule.

The most commonly held theory is that first advanced by Thompson, in 1868, namely that they have their origin in corpora amylacea which

under certain conditions, act as foreign bodies and set up an inflammatory reaction in the mucous membrane of the acini enclosing them, as a result of which calcium phosphates and carbonates are cast off, these impregnate the corpora amylacea and convert them into prostatic calculi. R. A. Moore has shown how poor drainage from the prostatic glands predisposes to the formation of a nucleus of desquamated epithelium and debris to form corpora amylacea. Young believes they arise by depositions from the secretions present in the ducts, just as calculi in the urinary tract arise from urine. Practically all of our patients, who have had all or part of their prostates removed for prostatic calculi, have shown evidence of infection, but whether such infection is primary or secondary to obstruction and the formation of calculi is difficult to say.

**Pathology** True prostatic calculi are usually multiple, small, rounded (without facets), and scattered indiscriminately throughout the parenchyma of the gland. Occasionally there will be a single large calculus or one large stone in association with numerous smaller stones. In one of our cases there was a single large stone in the right lateral lobe associated with multiple small calculi elsewhere in the gland.

These "seed" calculi are usually located within a distended acinus of the prostate. It is in these acini, which frequently are infected that there is a secretion of calcium which is deposited upon the corpora amylacea or other foreign substance. Occasionally a cluster of stones will be found in one lobe of the prostate while the remaining lobes are free of calculi. The probable explanation of this is that the ducts draining these glands have been occluded in the past, causing a chronic stasis or damming up of the affected lobe.

*Microscopically*, the portion of the prostate containing the calculi shows distended acini, the mucosal linings of which are infiltrated by lymphocytes or by polymorphonuclear leukocytes, depending upon the degree of infection present.

Prostatic calculosis may be found at any time of life, but is rare before the age of 30 years. Of the 23 patients reported on by Lowsley and Hawes, only one was under 40 years of age.

Benign adenomatous hypertrophy and prostatic calculosis not infrequently are present together (29 of 100 cases, Young, 18 of 23 cases, Lowsley and Hawes). The calculi are seldom, if ever, located within the adenoma, but are found between the adenoma and the capsule, embedded in the remnants of the true prostate. It is probable, in these cases that the calculi form in the parenchyma of the prostate and simultaneously,

or subsequently, the adenoma develops from the periurethral glands, and, as it gradually increases in size, forces the stones toward the capsule (Henline)

Frequently, however, calculi containing prostates show no sign of hypertrophy. They may be senile and fibrotic, with atrophy of the parenchyma and evidence of inflammation.

**Symptoms** Many prostatic stones cause no symptoms and are discovered accidentally. Signs and symptoms, when they do occur, are in no way pathognomonic. The most important signs and symptoms of prostatic stone are urinary symptoms, such as frequency, nocturia, dysuria, and difficulty in starting the stream, the actual passage of calculi either spontaneously or following massage, and localized or referred pain—in the perineum, suprapubic region, rectum, or, rarely, down the penile shaft. One of our patients complained of difficulty when urinating, but apparently suffered no other inconvenience from the 325 stones removed from his prostate. Less frequent complaints are of dribbling, incontinence, hematuria, and loss of sexual power. Occasionally there may be formation of a perineal abscess with a possible sequel of fistula. When the stones pass out by way of the urethra they are often confused with urinary calculi, and no doubt many pass wholly unnoticed since they are frequently too small to cause obstruction.

In many cases of prostatic calculi the symptoms are entirely overshadowed by those of associated pathological conditions, especially prostatic hypertrophy and chronic prostatitis.

**Diagnosis** It is frequently possible to make a presumptive diagnosis of prostatic calculi by the rectal palpation of a hard, circumscribed area, suggestive of stone or a nodule, or by the eliciting of crepitation, especially when the calculi occur in groups. Enlargement of the prostate and more or less boggy texture may be present owing to a concomitant chronic prostatitis.

Urethroscopic examination may reveal the presence of stones in the prostatic ducts. Endogenous and exogenous calculi may be differentiated by means of the urethroscope.

Positive diagnosis is made by roentgenography. In addition to establishing a correct diagnosis, the number, size and distribution of the stones may be determined, which aids in selecting the proper type of treatment. Prostatic calculi usually appear in the roentgenogram as multiple, tiny, seed-like opacities ranged behind the symphysis—rarely as single, larger stones. Cystourethrograms are of value not only in

revealing the prostatic calculi, but in determining the size of the prostate, the type and degree of obstruction to urination, and, if adenomatous hypertrophy is present, its extent

The conditions most likely to be confused with prostatic calculi are abscess of the prostate and carcinoma. In abscess there is usually asymmetrical, fluctuant enlargement and great tenderness to pressure. Calculi may suggest carcinomatous nodules to the palpating finger. In certain cases of prostatic stone there may be stony hard induration of the entire gland, which must be differentiated from carcinoma. The roentgenogram will serve to distinguish calculi from both abscess and carcinoma. A roentgenogram should also be taken in every case of chronic prostatitis that fails to respond to adequate courses of treatment, because of the possibility of finding calculi in the prostatic parenchyma.

Because prostatic calculi so frequently exist for long periods of time without producing symptoms, and because symptoms, when they do occur, are in no way pathognomonic, it is essential, before advising surgery, to determine that the calculi and associated infection are the source of the symptoms, and not associated pathology elsewhere in the urogenital tract.

**Treatment** For the treatment of exogenous calculi—urinary stones lodged in the prostatic urethra or formed in a connecting pouch—the reader is referred to the Treatment of Urethral Calculi (p. 696).

Regarding endogenous stones. If there are no subjective symptoms, and the calculi are very small and have been discovered during routine examination, they are best left alone. Massage of such a prostate is contraindicated. These patients should be examined at intervals. When symptoms of obstruction or infection develop, and a complete urological study indicates that they are due to the prostatic calculi and associated infection, surgery is indicated.

The surgical treatment of prostatic calculi is considered under Operative Treatment of the Prostate Gland (p. 932).

### *Diseases of the Prostate Gland in Children*

The prostate gland is rarely a source of trouble in childhood. Sometimes a prostatic abscess will supervene in the course of an acute prostatitis, of either gonorrheal or non specific origin. In such cases the abscess is drained exactly as in an adult. Occasionally a boy who practices masturbation will have prostatitis, which is easily relieved when the patient ceases the practice. Prostatitis in young boys may be a

cause of bed wetting. It is relieved by hot rectal douches, instillations of rivanol dextrose and other drugs into the posterior urethra, and restriction of fluids at night.

The only enlargement encountered in children is sarcoma, which in the past has invariably been fatal.

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## CHAPTER XXIX

### OPERATIVE AND NON-OPERATIVE TREATMENT OF THE PROSTATE GLAND

#### A OPERATIVE TREATMENT OF THE PROSTATE GLAND

##### *Anesthesia*

The question of anesthesia is of the greatest importance in prostatic operations. The choice of anesthetic rests with the surgeon, and will usually depend upon the patient's age and general condition, and upon the probable length of time of the operation. The object of anesthesia from the surgeon's standpoint, is to render the patient insensible to pain with the least harm to him.

*General inhalation anesthesia*, as a complete anesthetic, is undesirable (in many cases prohibited) in prostatic operations because of the cardiovascular and kidney lesions which so often complicate these cases. As a supplement to regional anesthesia, however, it has a definite place. Cyclopropane or ethylene is the first choice when electrical instruments are not used, and nitrous oxide when they are.

*Regional anesthesia* (low spinal or parasacral) is the anesthetic method of choice for any operation upon the prostate gland. There are several reasons for this. (1) The anesthesia, properly administered, is entirely effective for every type of operation—perineal, suprapubic, or transurethral. (2) The bleeding ordinarily is a fraction of the amount experienced under general anesthesia. Every type of inhalation anesthesia elevates blood pressure, the extent of this elevation varying in individuals, in the type of inhalation anesthesia used, and in the method of administration. This elevation of blood pressure results in much more bleeding than is experienced under regional anesthesia. (3) Fluids may be taken up to, during, and immediately after operation. This is a tremendous advantage, since almost every patient undergoing operation upon the prostate has some impairment of one or more organs of the urinary system making it important that fluids be forced as much as possible. If a general anesthetic is used, a certain period of abstention from the ingestion of fluids is essential. Moreover, the nausea and vomiting caused by certain

general anesthetics not only prevent the ingestion of fluids but also deplete the fluid content of the body by expelling the contents of the stomach

(4) Regional anesthesia persists for purposes of operation for about  $2\frac{1}{2}$  hours and the tissues remain anesthetized to a certain extent for from 6 to 8 hours. This is a great advantage for the following reason. After the stress and strain of an operation, the patient passes over into a period of relaxation during which there is a rebound in blood pressure. The blood pressure which was normal, slightly elevated, or markedly elevated (the last in case a general anesthetic has been used), now drops to normal or below normal. Ordinarily this state lasts for an hour or two. If the operation has been a long one and the loss of blood considerable, this period is lengthened and the blood pressure seriously depressed. If, while the patient is in a state of potential shock or in a pre shock state, there is added the element of pain, the possibility of his going into shock is greatly increased. Moreover, because of this prolonged partial anesthetization patients, who are never given morphine before operation, may frequently escape its use altogether, thus avoiding the bowel stasis and its attendant evils that accompany the use of morphine.

*Intravenous anesthesia*, with pentothal sodium, is often used to supplement regional anesthesia.

Generally speaking, for *perineal prostatectomy* we prefer spinal anesthesia for better risk cases utilizing 60 to 120 mgm of procaine hydrochloride or, occasionally, nupercaine or pontocaine. For aged patients and those who are essentially poor risks, we prefer sacral and parasacral anesthesia (50 to 60 cc of a 1 per cent solution of procaine caudally plus 2 to 3 cc injected into each sacral foramen). Should supplementary anesthesia be necessary, cyclopropane or ethylene is preferred. For *suprapubic prostatectomy* in younger patients and older men who are deemed good risks, we prefer low spinal anesthesia (60 to 120 mgm of procaine), supplementing it with a general inhalation anesthetic if necessary. In aged patients and those with cardiovascular lesions, local infiltration anesthesia (with 1 per cent procaine), supplemented with cyclopropane or ethylene, is preferred. For *transurethral resection*, sacral and parasacral anesthesia is usually satisfactory, and may be supplemented, if necessary, by nitrous oxide or by intravenous anesthesia (with pentothal sodium). Some surgeons prefer spinal anesthesia for this operation, especially in the better risk cases, because of the continuous troublesome flow of blood in the operative field.

These various anesthetic methods are further described in the chapter on Anesthesia in Urology.

*Routine Preoperative Preparation*

The patient is prepared for operation upon the prostate in the usual manner in regard to catharsis and enemas, except that, prior to prostatectomy, purgation is given at least 24 hours before operation, which allows the patient to get a night of undisturbed rest just before operation and to ingest sufficient fluids to make up for the fluids lost during the period of evacuation. A sedative (phenobarbital or nembutal, 0.1 Gm.) is given the evening before the operation. The patient is permitted a light breakfast and fluids up to the time of operation. (If general anesthesia is used, breakfast and fluids are, of course, withheld.) One hour before operation, phenobarbital or nembutal, 0.2 Gm. is given.

*Preparation of Operative Field*

For a suprapubic operation, the shaved field should include the external genitalia as well as the abdomen. For a perineal procedure it should include the external genitalia and the perineum to a point well beyond the anus. The skin is cleansed with green soap and water and sterilized with alcohol, 70 per cent, followed by tincture of merthiolate or tincture of zephiran, 1:1,000.

For transurethral prostatectomy, the preparation is similar to that for cystoscopy or urethroscopy.

*Operative Treatment of Hypertrophy of the Prostate*

**Indications for Prostatectomy** In general, removal of the prostate is indicated (1) in the presence of residual urine which does not subside under palliative treatment, (2) in cases of enlargement, without residual urine, where there is evidence of absorption of pus from the gland, (3) if there is uncontrollable pain.

**Selection of Patients and Technic** The selection of patients for operation is a matter which deserves the greatest consideration on the part of the doctor. This is particularly true in regard to patients suffering from prostatic obstruction, many of whom are aged and enfeebled by cardiovascular or other complications, making operation of any sort a hazardous matter.

In the treatment of bladder neck obstruction the choice of operation is of great importance. There are three routes by which the prostate may be reached for surgical intervention: (1) the suprapubic, (2) the perineal, (3) the transurethral. Some urologists have a preferred route which they use in all cases—a practice which should be roundly con-

demned. Each of these methods has a definite place in the armamentarium of the properly trained urologist, and he should be familiar with and utilize them all. No two cases of prostatic hypertrophy are precisely alike, and each case should be carefully considered and the method selected which seems best suited to the particular circumstances. In every case the aim of operation should be to restore urination to a condition approaching the normal, eliminate residual urine and back pressure, and clear up infection.

The ordinary suprapubic and perineal operations are both highly technical procedures. In the hands of experts, the functional results are about equal and the mortality of both low, considering the age and physical disabilities of a majority of the patients. The chief reason for the popularity of the so called Fuller Freyer suprapubic operation is that the surgeon can carry it out with little aid, whereas the proper performance of the perineal procedure requires the cooperation of a highly trained surgical team.

Widespread interest has been manifested in recent years by both the medical profession and the public in regard to transurethral resection of the prostate gland. The belief of both physicians and the laity that resection is a "minor" procedure, offering the most in results with the minimum of risk, has steadily increased the number of resections. This wave of enthusiasm has led to many exaggerated claims for the efficacy of this method to the exclusion of the open operation. Many urologists have attempted to relieve all prostatic obstructions, regardless of size or the pathology present by the resection method. This attitude is just as unwise as it would be to try and fit one size and style of shoe to every foot. The type of operation selected should depend upon the conditions present in the individual case. It is in the careful selection of cases and the use of all the routes of attack on the prostate that hope of lowering the mortality of prostatic operations lies.

Resection has a permanent and highly important place in surgery of the vesical neck, and with the passage of time it is evident that its scope and limitations are being better defined. It is applicable in a large percentage of cases of both benign and malignant hypertrophy. Many patients who, because of advanced years or marked cardiovascular and renal changes are unable to undergo open operation, can be relieved by this method. The shortened hospital stay is a boon to most patients, as well as to the hospitals and financial considerations, whether they should or not, inevitably influence the choice of operative procedures.

In our own service, the total mortality rate of prostatic surgery has been decreased by the addition of transurethral prostatectomy. This method is not, however, suitable for general use in all prostatic enlargements. Moreover, transurethral resection, far from being a "simple" operation, is a highly technical procedure, and is definitely as much of an expert's operation, and as serious, as radical prostatectomy.

Since no two cases of prostatic hypertrophy are exactly alike, no hard and fast rules can be laid down regarding their operative treatment. The indications and contraindications for transurethral resection of obstructions at the vesical neck are considered more fully on page 909. In general, resection is indicated in small enlargements of the middle and, in some cases, of the lateral lobes, in enlargements of the subcervical group of tubules, for fibrous bars, for temporary relief of obstruction at the vesical neck in certain cases of prostatic carcinoma, or in patients whose life expectancy is, for any reason, short, and for those who, because of age or serious complications, cannot undergo open operation.

Perineal or suprapubic prostatectomy is preferable in extensive bilobe or trilobe enlargements and in great median lobe hypertrophy. If the enlargement is mainly intravesical, suprapubic prostatectomy is the operation of choice. If the enlarged gland encroaches upon the prostatic urethra and is chiefly extravescical, perineal prostatectomy is to be preferred.

In certain patients with adenomatous hypertrophy of the prostate, who have ceased to have sexual intercourse, it is advisable to do a total prostatectomy because of the possibility of cancer developing in the posterior lobe, which is not removed during a conservative prostatectomy (Total Prostatectomy, p. 920). If the patient still retains a sexual life, however, total prostatectomy is not indicated.

Because surgeons are now operating for wider indications than ever before, they are undoubtedly overlooking the possibilities of non-operative treatment which they formerly considered before performing suprapubic or perineal prostatectomy. Resection should not be resorted to at the first indication of middle or lateral lobe intrusion. Non-operative methods, such as gradual dilatation by sounds or the Kollmann dilator, or the shrinkage method advocated by Kirwin, could undoubtedly take the place of many resections in those cases with mild symptoms of frequency associated with a very small amount of residual urine and very slight enlargement of the prostate. To the older, non-operative methods of treating benign hypertrophy has recently been added a new method—



namely, glandular therapy, based chiefly on the work of Lower and his associates at the Cleveland Clinic, and of Laqueur, of Amsterdam, and his co workers (Hormonal Therapy, p 840)

**Preoperative Preparation For Prostatectomy** The most important step in any type of prostatectomy is the preparation of the patient. This consists primarily in properly managed drainage. Careful preliminary preparation has not only materially lowered the mortality of prostatectomy but has greatly added to the number of those ultimately fit for operation.

**Drainage** Considerable caution should be exercised when drainage is first instituted. In many cases of retention of long standing uremia has resulted from the sudden withdrawal of the entire amount of residual urine. It is, therefore, wise to decompress the bladder gradually before undertaking complete and continuous drainage. It is our custom to replace with sterile boric acid solution approximately one half the volume of fluid removed from the bladder of a patient suffering from retention, repeating this procedure every 6 or 8 hours for several days if catheterization is tolerated well by the patient. If not, the tube may be fixed in the urethra and the fluid released when necessary and the bladder partially refilled with boric acid solution. A great many decompressing apparatuses have been devised, one of the best being that of Young and Shaw. Under ordinary circumstances the simplest methods are the best. Attaching the end of the tube to a bottle on a stand which is so placed that the tube starts at 2 feet above the bladder level and lowering it 2 or 3 inches a day, as advocated by Hamer, of Indianapolis, is an excellent method that can easily be carried out in any sick room.

After the patient has been delivered from the danger of uremia by gradual decompression of his bladder complete drainage is instituted. There are three different ways of accomplishing this, (1) by suprapubic drainage (suction or syphon), (2) by indwelling urethral catheter, (3) by repeated (interim) catheterization.

**Repeated catheterization**, even under the most favorable circumstances, carries with it the danger of traumatism, starting up of retention, or stirring up of a latent infection if continued for any considerable length of time. **Suprapubic drainage** is necessary when there is a considerable degree of urinary infection or renal impairment. In our clinic, suprapubic drainage is accomplished by means of the Kenyon double tube and suction furnished from a general system by a wall vacuum (Suprapubic Cystostomy, p 1105). With better education of both the medical pro-

fession and the lay public in the importance of early treatment of prostatism the number of cases requiring preliminary suprapubic cystostomy has steadily declined. In the majority of cases one-stage prostatectomy with preliminary drainage by *indwelling urethral catheter* is now not only possible but advisable. If as occasionally happens the response is not satisfactory a suprapubic cystostomy is performed and the patient allowed to drain until his general condition fulfills operative requirements. The use of the Foley self retaining catheter has done away with most of the discomforts and inconveniences formerly attending indwelling urethral catheterization.

*The length of the drainage period* varies with the individual patient. The earlier stage at which many prostatic patients now seek medical aid has materially lowered the average length of the preprostatectomy drainage period. The present average is about 3 to 7 days whereas a decade ago the average was approximately 10 to 14 days. Some patients of course still require much longer treatment. Drainage should be continued until the patient has attained his maximum of renal efficiency as determined by the comparison of a series of phenolsulphonphthalein and blood-chemistry tests. The kidneys usually respond well to treatment unless there is long standing infection or destruction of tissue and as the back pressure is relieved and the renal function improved hypertension which is very common in these cases is lowered. When the patient has reached his peak of improvement it is advisable to operate because like athletes in training these old gentlemen sometimes go stale and begin to slump. It then takes a long time for the patient again to reach his maximum of functional efficiency.

Of even greater importance than the laboratory tests are the general aspect and spirit of the patient. We are always pleased to have the patient express a desire to proceed with the second stage of the operation because this indicates that his morale is good and is usually a reflection of his general bodily condition. Regardless of the satisfactory results of the laboratory tests if he has not reached a condition where he can face the ordeal of operation with confidence and even cheerfulness the operation should be postponed until he feels fit and anxious to proceed.

*Routine Examination* A plain x ray is always taken to determine the size, conformation and location of the kidneys. By this means an occasional case of bilateral polycystic kidneys has been discovered and the patient's life saved by not operating. If there are stones in the upper urinary tract it is important information which the surgeon receives from an x ray examination. Routine cystourethrograms are also made

An electrocardiogram is regularly made. The information thus gained, whether it be favorable or unfavorable, is of great importance to the surgeon.

Blood pressure estimations over the period of preoperative preparation are most helpful. A subnormal blood pressure or a too sudden drop from an abnormally high blood pressure, is viewed with alarm. A fall in blood pressure is usually noted during the period of preliminary drainage, and is probably due to the relief of the general bodily mechanism from the retention in the blood of toxic elements resulting from obstruction and back pressure.

*Fluids Diet.* Fluids should be forced during the preoperative course to about 4 000 cc. a day unless the patient has cardiac disease. If the patient is unable or refuses to take the required amount by mouth, the oral intake can be augmented by the administration of fluids by rectum, hypodermoclysis, or intravenous injection. A very exact record must be kept of both the fluid intake and output.

The patient is given a regular or high caloric diet unless diabetes or some other special contraindication exists.

*Rest.* Both from the physical and the psychological standpoints, it is preferable to keep these elderly patients up during the day unless there is elevation of temperature or some other definite contraindication.

*Medication.* When the urine is infected, a urinary antiseptic should be given up to the time of operation. The newer sulfa drugs, in small doses, are satisfactory for this purpose. We usually prescribe sulfadiazine, 0.5 Gm. 4 times a day. For the occasional patient who does not tolerate well even this small dose of a sulfa drug, methenamine may be used—0.3 Gm., dissolved in a glass of water, every 2 or 3 hours. Acid sodium phosphate, 0.3 Gm. is given with the methenamine. For stubbornly alkaline urine, pyridium, 0.1 Gm. 3 times a day, is very useful.

A low carbon-dioxide coefficient of the blood means hyperacidity, which is relieved by the administration of sodium bicarbonate by mouth or rectum in a 5 per cent solution.

*Bladder Irrigations.* Whenever a patient has an indwelling urethral catheter, this must be irrigated once in 24 hours to prevent the formation of urates. A 2 per cent solution of boric acid is usually employed unless active bleeding or considerable infection is present. When there is bleeding or severe bladder infection much more frequent irrigation becomes necessary. These patients are usually put on intermittent bladder irrigation. Normal saline or silver nitrate solution, 1:10,000 is usually used.

when bleeding is present, saline or potassium permanganate solution, 1:10,000 when there is severe infection

*Care of Drainage Tubing and Bottles* The rubber drainage tubing and glass connecting tubes must be changed for clean, sterile tubing every 24 hours, and the drainage bottle every 12 hours

*Final Preoperative Examination* On the day of operation the patient is given a final thorough physical examination which includes the general appearance, head (eyes and tongue particularly), chest, abdomen, and extremities. A careful review is made of his temperature and pulse rate charts and blood pressure comparisons. The advantages of such a course have been repeatedly exhibited to us in our urological work. Not infrequently a patient, apparently entirely ready for surgical intervention, has been discovered at the last moment to have some complicating condition making postponement of the operation advisable.

*Technic of Preliminary Cystostomy* The following technic, now in use at Bellevue Hospital (New York), offers certain advantages over older procedures and has been used most successfully by Dr. William Delzell of that institution, to whom we are indebted for permission to incorporate it in this text book.

The bladder is filled with a solution of acriflavine, boric acid or other neutral medium. A catheter is left *in situ* in the distended bladder, the distal end of the catheter being closed with a clamp to prevent escape of the distending fluid. By a linear incision carried through the skin and fascia, the recti muscles are split, the operator stopping to tie off all bleeding points as they appear. The transverse fascia is incised with a U incision just above the pubic bone, and the peritoneum carefully peeled back, using a gauze covered finger, with as little trauma as possible. The exposed bladder is readily recognized by its characteristic blood vessels, and two Allis clamps are placed upon its wall.

At this point an assistant releases the clamp upon the catheter, permitting the distending fluid to flow out until the bladder is entirely empty. He can accomplish this by slipping his hand beneath the sterile cloth, if the catheter has not previously been connected with a drainage tube leading to a container on the floor. It is better, however, to have such a connection arranged beforehand so that the assistant can reach the clamp without the necessity of feeling beneath the sterile draping.

Incision through the bladder wall is now made between the two Allis clamps, *without danger of infected fluid coming in contact with the wound or splashing into the space of Retzius*. The operator now inserts his

gloved finger into the wound, to examine the enlarged prostate and the interior of the bladder, after which the glove on the examining hand is removed and a fresh sterile one assumed in its place. The procedure is then completed in the usual manner (Suprapubic Cystostomy p 1105)

**Suprapubic Prostatectomy** In general enucleation of the prostate gland by the suprapubic route is indicated in cases in which the prostatic intrusion is mainly intravesical

The technic preferred by us is the so called Fuller Freyer operation, originated almost four decades ago

*Preliminary Bilateral Vasectomy* It is our practice to perform bilateral vasectomy before every suprapubic prostatectomy in order to avoid postoperative epididymitis as the orifices of the ejaculatory ducts are apt to be injured during enucleation and laid open to infection

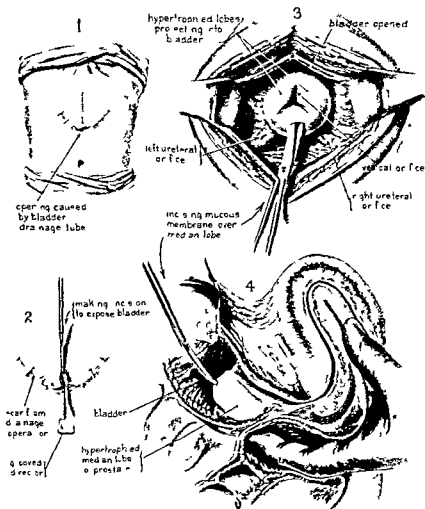
*Technic of Suprapubic Prostatectomy* The properly prepared and anesthetized patient is placed on the operating table in such a manner that he may readily be put in the Trendelenburg position. If there has been a preliminary cystostomy, the high suprapubic fistula from this is incised downward toward the symphysis and the bladder wound incised toward the vesical orifice. If there has been no preliminary cystostomy, the bladder is exposed through the incision preferred by the operator (vertical midline inverted V, etc.) and the bladder wall grasped by two Allis clamps and incised to the desired length between them

The capsule of the most projecting portion of the prostate is opened with scissors. The operator's finger is inserted through the opening, the line of cleavage established and the enucleation accomplished by sweeping the index finger in all directions inside the capsule until the enlarged gland has been entirely detached from it. Great care must be taken to avoid splitting the top of the vesical orifice, with the inevitable injury to Santorini's plexus and the severe hemorrhage which this accident involves

When the finger reaches the verumontanum, some difficulty in enucleation is invariably encountered. As this is the most distant point that the finger endeavors to reach, a short finger may not be able to attain it. Consequently, the gland may have to be grasped and torn away, usually bringing with it some or all of the verumontanum's mucosa. The ejaculatory duct orifices are thus denuded of their natural protection against infection, and epididymitis is likely to occur if bilateral vasectomy has not previously been done

The two fingers in the rectum while the prostate is being enucleated,

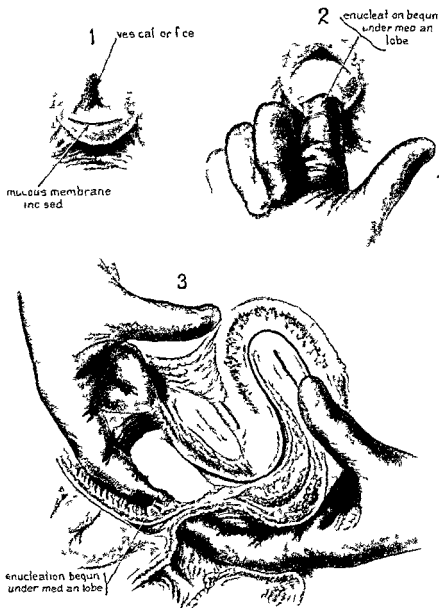
steadily the gland and push it forward toward the suprapubic opening, making the enucleation far easier



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FIG 187 Suprapubic prostatectomy (1-2) The high suprapubic fistula from the preceding cystostomy is incised downward. The bladder wound is incised toward the vesical orifice. (3) The bladder has been opened, exposing the intruding prostate. The capsule of the most projecting portion (the median lobe here) is incised. (4) A finger in the rectum pushes the prostate well up into the bladder (sagittal view).

The prostate enucleated, the patient is put in the Trendelenburg position. All remaining tags of tissue are cleared away, leaving the



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FIG 188 Suprapubic prostatectomy (1) The capsule slit (2) The finger is inserted through the opening and enucleation commenced (3) Sagittal view of enucleation

prostatic capsule smooth, with no debris to undergo necrosis and encourage infection of the cavity left by removal of the gland. Using sponge forceps, a sponge of gauze is dipped in hot saline and inserted into the

prostatic cavity to control the immediate hemorrhage. Pressure can be put on by the assistant. The cavity is then packed with vaseline gauze. As this gauze is a semifluid substance, the prostatic capsule will expel a portion of it should the packing be too tight, thus automatically relieving any undue pressure. A Kenyon double suction tube is fixed in position with plain catgut at the highest point in the bladder incision and

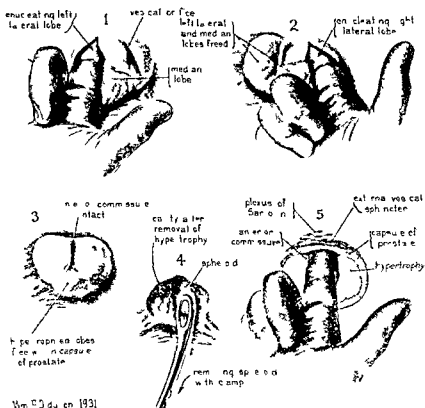


FIG. 189. Suprapubic prostatectomy. (1 to 5) The enucleation of the prostate is continued care being taken to avoid splitting the top of the vesical orifice with resultant injury to Santorini's plexus.

the highest point in the abdominal wound. The bladder wall is repaired by catgut sutures, one of which is tied around the suction tube. A small cigarette drain is inserted along the suture line of the bladder. The abdominal wound is closed in layers, using plain catgut for the recti and fascia, and, for the skin, interrupted sutures of silk, dermal, or silkworm gut, one of which is tied around the suction tube.



*Prostatectomy Hemostatic Bags* One of the numerous prostatectomy bags for the arrest of hemorrhage is often used in place of the vaseline gauze. The Pilcher and Brake bags are small, piriform rubber bags with a long urethral tube and a short tube which extends out through the suprapubic wound. The urethral tube of the Pilcher bag is in one piece with the bag, but the catheter of the Brake bag is separate and is inserted through an inner tube in the center of the bag. These hemostatic bags are inserted as follows. After the prostate has been enucleated, the glove is changed for a sterile one. A sound is passed through the urethra and the catheter end of the bag is inserted on the sound and drawn through the urethra. The bag is then inflated with water through the suprapubic tube and inserted into the prostatic cavity and placed under tension (using the Hamer anchor) for 2 to 6 hours, depending on the amount of bleeding. The tension is then partly released, leaving the water filled bag in place. After 12 hours the tension is entirely released, and after 24 hours (usually) the bag is deflated but still left in position. If no hemorrhage occurs within 48 hours, the bag is removed suprapubically, and, in the case of the Pilcher bag, a urethral catheter is inserted. When the Brake bag is removed, its separate catheter remains in position.

*Removal of Gauze Packing* The packing is removed 38 to 48 hours after operation—30 to 60 cc of 2 per cent procaine borate solution first being instilled into the bladder to ease the pain of removal.

*Perineal Prostatectomy* If the prostatic hypertrophy is largely extravescical, removal of the prostate by the perineal route is usually preferable.

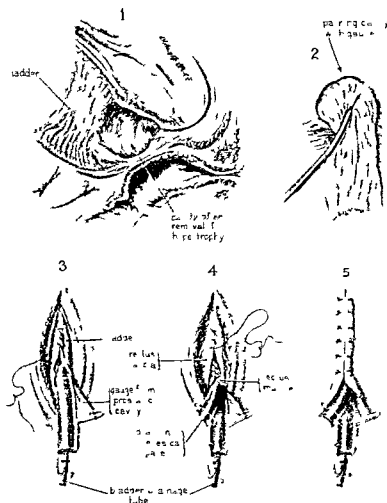
The technic preferred by us is a modification of Young's conservative perineal prostatectomy.

*Preliminary Vasectomy* When the prostate is enucleated by the perineal route according to our technic, the verumontanum is respected and the orifices of the ejaculatory ducts do not suffer injury. Therefore, preliminary vasectomy is unnecessary. Some operators, however, do this procedure on each patient.

*Technic of Perineal Prostatectomy* Perineal prostatectomy is frequently preceded by a suprapubic cystostomy for drainage, but in many cases drainage is secured by the use of the indwelling catheter, so that there is no suprapubic wound.

The patient is placed on the operating table in the exaggerated lithotomy position. A Lowsley tractor is passed into the bladder through the urethra and its blades opened. A crescentic incision is made through

the perineal skin about one inch above the anus, and the space on each side of the central structures opened by sharp and blunt dissection. The



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FIG 190 Suprapubic prostatectomy (1) Sagittal view showing the appearance of the cavity after removal of the prostate (2) The cavity is packed with petrolatum gauze (or one of the numerous prostatectomy bags may be used instead of the gauze) (3) A Kenyon double suction tube is fitted in position at the top of the vesical wound, and (4) a cigarette drain is inserted at the top of the wound in the body wall (5) The skin incision is closed with the tube and drain emerging at the top

central tendon of the perineal muscles is then incised behind the point where the lateral perineal muscles join it. This allows the central struc-

tures to be pulled upward with the bulb and lateral perineal muscles. A Kocher clamp is fixed to the posterior part of the central tendon and held in the left hand for the purpose of traction. The index finger of the left hand is inserted into the rectum and the hand covered with a towel. The dissection is carried deeper and the recto-urethralis (the important reflection of the levator ani which attaches the rectum to the urethra at



FIG. 191 Perineal prostatectomy. With the fingers in the ischio-rectal fossa the central tendon behind the transverse perineal muscles is incised (after a crescentic incision has been made through the skin and the ischio-rectal fossa on each side of the central structures opened by sharp and blunt dissection).

the apex of the prostate) is incised. The levator ani is then dissected from the posterior surface of the prostate which is recognized by the glistening fascia of Denonvilliers covering its posterior surface. Thus not only has the posterior urethra not been opened—an extremely important point in the prevention of incontinence—but often it is not even seen. The left index finger is removed from the rectum and the glove changed. A posterior retractor is placed in position.

An inverted V slit is made in the posterior surface of the prostate (its apex being at the exact apex of the prostate) and carried down to the posterior urethra. When this tongue-shaped flap is drawn back, the verumontanum is seen. A transverse incision is made in front of the verumontanum and deepened in such a manner as to separate the middle lobe from the posterior lobe with its dividing fibrous leaflet which con-

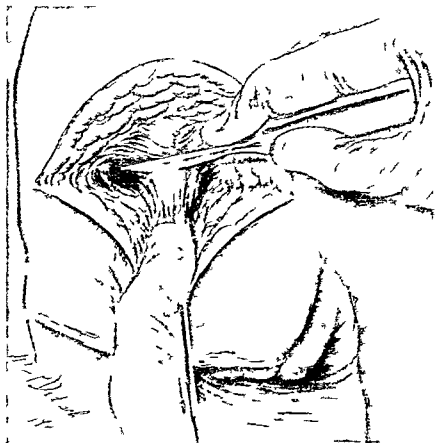


FIG. 192. Perineal prostatectomy. The index finger of the operator's left hand is inserted into the rectum, protecting that structure and the recto-urethral muscle is incised.

veys the ejaculatory ducts through the prostate. This procedure leaves the ejaculatory ducts uninjured and still retaining their normal orifices—a fact that accounts for the low incidence of epididymitis following our technic. The enucleation of the gland is continued by separating the presenting hypertrophied portion from the capsule. The index finger is inserted into the prostatic urethra and the anterior commissure split,

care being taken not to injure the internal sphincter any more than is absolutely necessary. Should the sphincter be split at the top, there is grave danger of tearing into the plexus of Santorini, with resulting hemorrhage. The hypertrophied mass is now grasped with the Lowsley clamp and removed *en masse*.

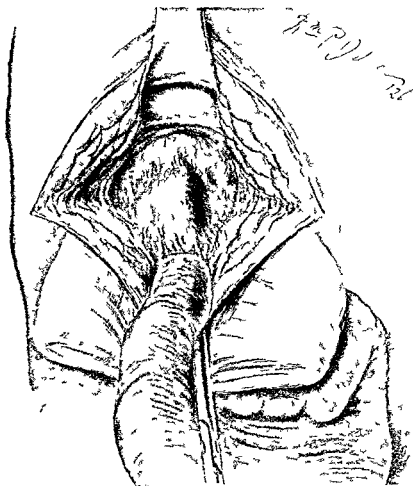


FIG. 193 Perineal prostatectomy. The bulb is retracted upward. The finger in the rectum exposes the apex of the prostate. The groove between the rectum and the prostate is seen.

The vesical orifice is grasped with an Allis clamp, the Lowsley tractor closed and removed, and the finger introduced into the vesical orifice to identify and remove any fibrous tags, small nodules of prostatic tissue, or a subcervical gland enlargement. These half destroyed tissues, if allowed to remain, constitute a future menace to the free passage of

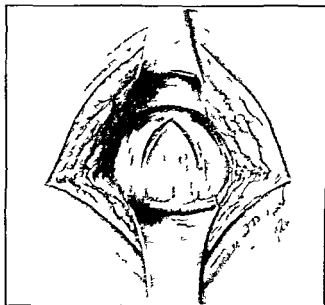


FIG. 194 Perineal prostatectomy. The posterior surface of the prostate having been exposed by dissection from it of the levator ani, an inverted V incision is made through it and into the posterior urethra.

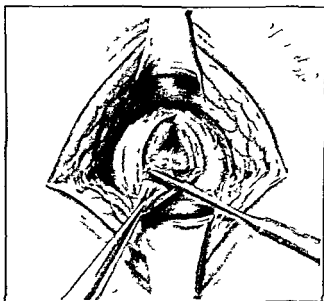


FIG. 195 Perineal prostatectomy. Retraction of the V shaped flap reveals the intact verumontanum. The middle lobe is separated from the posterior lobe by sharp and blunt dissection.

urine or they may become necrotic and set up an infection of the entire prostatic cavity. Pieces of prostatic tissue of considerable size can be

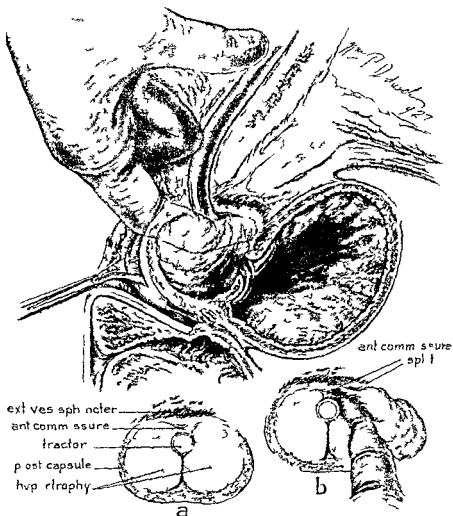


FIG 196 Perineal prostatectomy (a) Cross section of the enlarged prostatic lobes with the retractor in position (b) Cross section showing the finger separating the adenoma from the capsule of the prostate. The large drawing is a sagittal view of the bladder and prostate. The index finger is shown splitting the anterior commissure.

removed with the Lowsley clamp through the vesical orifice without difficulty.

A No 24 F Foley self retaining catheter is introduced into the bladder through the urethra and secured by filling the small encircling bag.

The membranous urethra just external to the apex of the prostate is

plicated by a mattress suture of chromic ribbon gut, which greatly reduces the chances of postoperative incontinence of urine. The vesical orifice and prostatic capsule are packed with sufficient vaseline gauze to arrest any bleeding. The floor of the pelvis is closed by approximating the two ends of the levator ani muscle with a chromic catgut suture. The skin is closed with interrupted silk or dermal sutures.

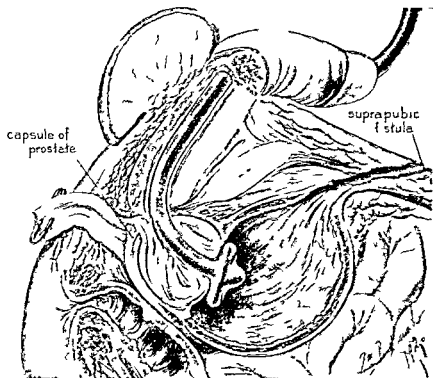


FIG. 197 Perineal prostatectomy. Sagittal view showing the completion of the operation with a Pezzer catheter in the bladder and the capsule of the prostate and vesical neck filled with vaseline gauze for the purpose of hemostasis. (We now use the Foley catheter.)

**Removal of Gauze Packing.** The gauze is removed in 24 hours or less under ordinary circumstances. The removal of the packing must be done very gently, as otherwise the pain is excruciating. It is sometimes necessary to give gas for this procedure.

**Belt's Approach in Perineal Prostatectomy.** In the approach recently described by Belt, Ebert, and Surber, use is made of the cleavage plane present between the longitudinal muscle fibers of the rectum and the external sphincter ani muscle. By using this route the capsule of the



prostate can be exposed bloodlessly and without cutting a nerve. The approach, as described by its authors, is as follows.

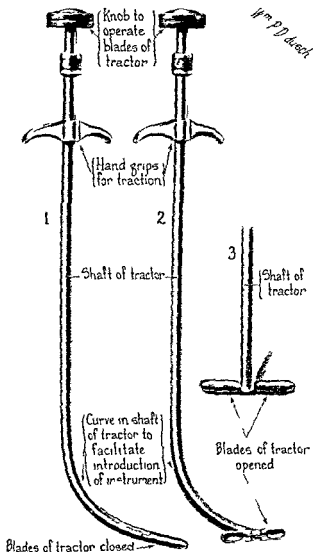


FIG 198 Lowsley prostatic tractor, with curved shaft and blades that are opened and closed by means of a knob

A curving transverse perineal incision  $1\frac{1}{2}$  cm from the anal mucosa exposes the delicate fibers of the median raphe. These are cut, revealing the arching fibers of the external rectal sphincter, which are raised to disclose the glistening longitudinal muscle layer of the rectum

The anal canal and rectum are depressed and pushed backward, defining the central tendinous plane of the perineum. The areolar tissue and

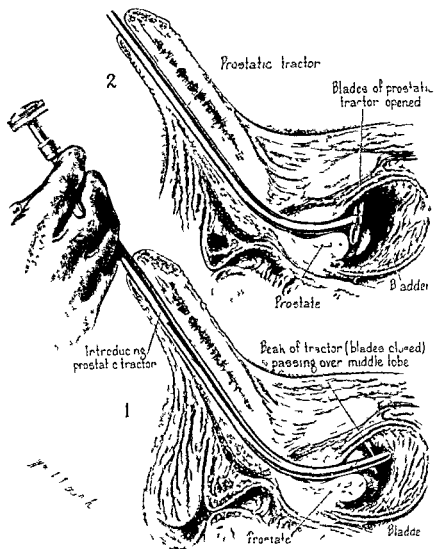


FIG 199 Lowsley prostatic tractor (1) Shows method of introducing the tractor. Without the curved shaft it would be difficult if not impossible to pass the instrument into the bladder. (2) The blades of the tractor are opened and traction about to be maintained.

tendinous portion of the recto urethralis muscle joining the rectum to the base of the perineal membrane are snipped through revealing the anterior free borders of the levatores ani and the flat sheath of the recto

urethralis The recto urethralis is split medially and retracted laterally with the levatores ani, exposing the fascia of Denonvilliers covering the posterior surface of the prostatic capsule

**Control of Hemorrhage Following Prostatectomy** Steps to prevent hemorrhage should be instituted at the time of operation To rest in the hope that further packing or other manipulations might be accomplished in case the patient continues to bleed for several hours after operation usually results in disaster, because even slight manipulation causes pain,

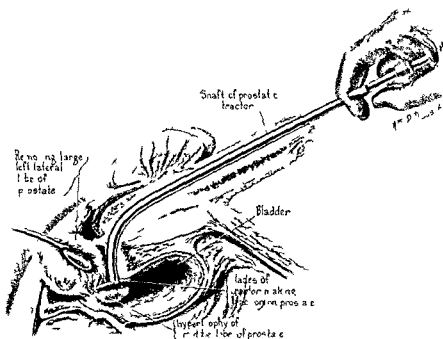


FIG. 200 Lowsley prostatic tractor Sagittal section showing removal of large left lateral lobe of the prostate with the gland being drawn and held downward by the tractor

and very little pain, inflicted at a time when the patient is in a state of depressed blood pressure, will have a profound effect and may even throw him into shock The wise surgeon therefore, stops the hemorrhage before he begins to sew the wound

This is easily accomplished in perineal prostatectomy, because bleeding points can be observed clamped and ligated in a satisfactory surgical manner The general ooze, which always occurs, is controlled by packing the cavity of the prostatic capsule lightly with vaseline gauze Any cavity that is packed too tightly will attempt to expel the foreign body,

and the resulting spasmodic contractions tend to cause continued hemorrhage

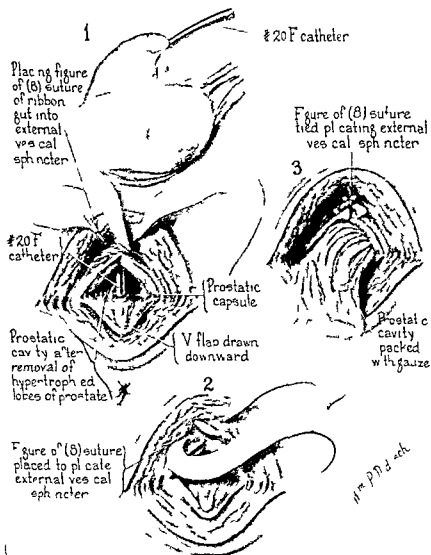


FIG 201 Plication of the external vesical sphincter with ribbon gut following perineal prostatectomy helps to prevent incontinence of urine

Suprapubic prostatectomy presents a very different problem. The cavity whence the enlarged prostate has been removed is difficult of access. In case of severe hemorrhage, it is possible to put the patient

in the Trendelenburg position expose the area and clamp and tie off bleeding vessels and this should always be done



FIG. 202 True middle lobe enlargement of the prostate with a subcervical group enlargement embedded into it



FIG. 203 Enormous true enlargement of the middle lobe of the prostate gland

**Postoperative Care Following Prostatectomy** The immediate post operative care of the prostatectomy patient is of the greatest importance. A well trained nurse is invaluable in these cases.

It is important to keep the patient dry and warm and to transport him to his bed as quickly and quietly as possible. If he has had spinal anesthesia, the head should be kept lowered for at least 8 hours. Elderly patients in particular should be turned from side to side frequently while in the Trendelenburg and horizontal positions in order to prevent hypostatic pneumonia and to stimulate the circulation as a preventive against the formation of thrombi. Shallow and infrequent respirations may be changed to deep, regular respirations by 5 minute inhalations of oxygen and carbon dioxide at frequent intervals.

*Blood pressure estimation* is the most important single item in the observation of the patient for the first 24 hours. The blood pressure

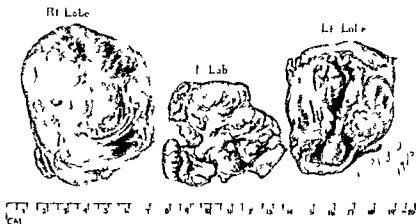


FIG. 204 Specimen removed by perineal prostatectomy. Note the relative size of the three enlarged lobes in this particular case.

should be taken every 2 hours or oftener until it has passed through its period of depression and has again risen to a safe level. Both hemorrhage and the drop in blood pressure are much less in prostatectomy under regional anesthesia than in operation under any of the inhalation anesthetics.

*Postoperative pain* should be avoided by every means possible. When regional anesthesia with procaine has been used the anesthetic effect continues to a certain extent for from 6 to 8 hours, so that the patient is tided over the trying period of depression and usually sleeps well the night after operation.

*The drainage apparatus* is connected with the suprapubic drainage tube

or the urethral catheter as soon as the patient is settled in bed. The drainage tubes must be frequently inspected to make sure that there is constant free drainage, and must be changed every 24 hours for clean, sterile tubing. The drainage bottle should remain uncovered for several days after operation so that bleeding, if it occurs, may be detected promptly. The bottle is changed every 12 hours. *In suprapubic cases*, the drainage tube is usually removed on about the sixth day, drainage thereafter being maintained by means of a tube in the urethra until the suprapubic wound is healed. We use a suprapubic suction cup, held in place by adhesive straps, to take care of any suprapubic leakage and bridge the period between the removal of the drainage tube and the healing of the suprapubic sinus (see p 1151). The cup is connected to the suction apparatus in the same manner as the double suction tube. Some surgeons use the cup without a catheter in the urethra. *In perineal cases*, the drainage tube is now inserted through the urethra (Foley catheter), and is left in until the wound is healed.

*The urinary output* of the prostatic patient is of the greatest importance. The chief object of the preoperative treatment is the securing of good drainage. Postoperatively, fluids should be given in increasing amounts as soon as the immediate effects of the operation have worn off. As a rule there is little or no vomiting following regional anesthesia, so that small amounts of fluids may be given almost immediately. Generally speaking these patients should take from 3,000 to 4,000 cc of fluids daily. Both the fluid intake and output must be very carefully measured and charted (Charting Fluid Intake and Output p 1154). Prompt measures must be instituted to stimulate the kidneys to increased activity if they appear sluggish. This may be accomplished by infusions of normal saline, with or without glucose, and by the use of drugs such as potassium citrate, caffeine, and thyroid residue.

*Perineal irrigations* following perineal prostatectomy keep the area clean and relieve any pain and inflammation. The soiled dressing is removed and the perineal area is cleansed with green soap solution and water. It is then irrigated with warm hydrogen dioxide, rivanol dextrose, 1:2,000, bichloride of mercury 1:1,000 or oxy cyanide of mercury, 1:1,000 and a fresh, sterile dressing applied.

*Maintaining the patient in a semi-erect position* as soon as possible after the operation is important for several reasons. (1) the upright position favors drainage, (2) it greatly reduces the danger of hypostatic pneumonia. (3) it has a good psychological effect. • *Following perineal prosta*

*lectomy* the patient is usually allowed to sit up in bed on the third or fourth day a careful examination of his legs and thighs having first been made to make sure that no thrombus is present Were this examination general we feel many a fatality due to embolus might be avoided by recognition of the condition The patient is kept lying quietly in a semi-reclining position for several days longer and should be prevented from straining at stool as fatal emboli are sometimes dislodged by such efforts About the seventh or eighth day he is encouraged to sit up in a chair a very tight binder having first been applied so that the wound will not be interfered with He should sit on a hard surface—never on a rubber ring or an air mattress At the first sign of syncope or collapse he should be returned to his bed but if he stands it well he should be allowed to sit up for 20 to 30 minutes As his condition improves he should be encouraged to take short walks around his room These slight but gradually prolonged activities will accustom his heart to future exertions and are most important in the patient's convalescence *Following suprapubic prostatectomy* a urethral catheter is inserted about the sixth postoperative day and the patient is lifted from his bed on the seventh day fitted with a tight binder and permitted to sit in a chair for 30 minutes this period being gradually lengthened

*Dilatation of the sphincter* by sounds or preferably by the Kollmann dilator is done three weeks after prostatectomy This procedure is necessary to overcome the tendency to stricture of the vesical orifice due to contraction of the circular wound during healing and scar formation.

**Postoperative Complications** Because of the advanced age of many of these patients the possibility of complications following prostatectomy is greater than in general surgery

**Shock** The use of spinal or sacral anesthesia in prostatectomy greatly reduces the danger of shock but one must be prepared to deal with it nevertheless Shock is induced by loss of blood traumatization of the tissues with consequent pain injury to the nervous mechanism and certain toxic substances It is marked by very low or imperceptible blood pressure pallor cold clammy skin weak thready pulse and rapid shallow breathing

The ordinary methods of combating shock are familiar to every one (1) raising the foot of the bed on shock blocks (2) keeping the patient warm and absolutely quiet (3) administering fluids and stimulants by mouth or parenterally Normal saline solution injected intravenously raises the blood pressure in from 30 to 50 minutes and often tides the patient



over satisfactorily. However, we prefer the intravenous injection of a 5 per cent solution of glucose. A transfusion of properly tested blood may be given in extreme cases. An important thing to remember in shock is that many a person has been "killed by kindness." Close, trained observation is essential, but all the various ways of bedeviling a sick man, by unnecessary hospital routine measures, should be scrupulously avoided. More patients have been brought out of shock by intelligent neglect, after proper stimulative treatment has been given, than by elaborate routines which continually annoy the shocked patient.

*Hemorrhage* Some general oozing from the vascular prostatic bed may persist despite packing, but severe postprostatectomy hemorrhage is relatively uncommon. However, it may occur in spite of the utmost care at the operating table, and is only dealt with by prompt and efficient cauterization or packing, or, if a hemostatic bag has been left in the prostatic bed, by the application of traction on the urethral tube, which usually will check the bleeding. Hemorrhage is manifested by symptoms of shock, clotting of the drainage in the bottle, and the passage of blood clots through the urethra (if the patient has had a suprapubic operation) and through the urethral catheter or into the dressings (if a perineal procedure).

If the patient has a suprapubic wound, it is relatively easy to remove the drainage tube and pack or repack the prostatic bed, but in a one stage perineal prostatectomy a more difficult problem presents itself and must be dealt with as indicated. Often suprapubic cystostomy is the method of choice. Fortunately, the control of hemorrhage is easily accomplished at the time of operation in perineal prostatectomy because bleeding points can be seen, clamped, and ligated in a satisfactory surgical manner, so that severe postoperative hemorrhage is uncommon.

When hemorrhage is slight, intravenous injections of saline, glucose, or gum glucose are given, but if there is much loss of blood, a transfusion of properly tested blood may be necessary.

*Cardiac Complications* In patients who have been properly prepared for operation it is surprising how seldom a bad heart will begin to decompensate. Occasionally this does occur, and one may see auricular fibrillation, dilatation, or heart block. When this happens, the heart is stimulated with appropriate drugs. It is often advisable to put such a patient in an oxygen tent.

*Pulmonary Complications* *Massive lung collapse* is a very rare sequel to prostatectomy, but may happen.

*Embolism* of a lung is one of the complications most feared by every surgeon. When it occurs, the patient is always seriously embarrassed and often dies. Both the circulatory and the respiratory systems are affected. It is usually necessary to stimulate the heart and put the patient in the oxygen chamber as well.

*Pneumonia* is not as common a complication with regional as with general anesthesia. A careful nurse will move the patient up and down and gently roll him to one side and then to the other in an endeavor to prevent passive congestion of the lungs which may induce pneumonia.

*Gastrointestinal Complications* *Acute gastric dilatation* is relieved by passing one of the numerous tubes into the stomach. The tube may be inserted through the nose and left in position for several days for the purposes of gastric lavage and the release of gases.

*Ileus* occurs all too often. It is usually relieved by colonic irrigations, pituitrin and the use of turpentine stools. Poultices and other forms of heat applied to the abdomen are helpful. Rarely it may be necessary to perform an enterostomy to relieve the excessive formation of gas.

*Renal Complications* Both before and after operation the urinary output of the prostatic patient should be constantly under observation and prompt measures instituted to stimulate the kidneys if they appear sluggish. *Anuria* may occur postoperatively, in which event heroic measures are necessary to start the secretion of urine. One or more of the following measures will usually prove successful: infusions of hypertonic salt solution and glucose, 50 per cent, irrigations of the bladder and renal pelves with warm solutions, the administration of certain drugs such as caffeine, potassium citrate, and thyroid residue, and, in extreme cases, decapsulation of the kidneys. No one method is always successful but each should be given a trial when indicated.

*Toxic nephritis* is manifested by a dry tongue, fetid breath, vomiting and diminished output of urine. Efforts should be made to eliminate toxins by means of hot applications to the kidneys and high colonic irrigations, as well as by the measures advocated in anuria.

*Postprostatectomy Follow-up* The postprostatectomy patient should be under the care of his surgeon for an indefinite period. Frequent dilatation with sounds or the Kollmann dilator to prevent stricture at the vesical orifice, should be done. The patient's diet and methods of elimination should be carefully supervised and ample relaxation insisted upon. Hormonal therapy (testosterone) has been found helpful in the after care of many of these patients. A postprostatectomy patient may

easily outlive his contemporaries if he is temperate in his appetites and regular and moderate in his habits of work and relaxation

**Transurethral Resection of the Prostate** During the last two decades a vast improvement in instruments and electrical currents has brought transurethral resection of obstructions at the vesical neck into great prominence some urologists even going so far as to attempt to replace perineal and suprapubic prostatectomy by this method The idea of attempting to overcome obstructions at the bladder neck by transurethral manipulations is by no means a modern one Various periods in surgical history have been marked by enthusiasm for this method of attacking the prostate, and bitter controversies have resulted As far back as 1603 the Faculte de Paris passed a vote of censure against Turguet de Mayenne for practicing this method

Advances in knowledge of the anatomy and pathology of the bladder neck, and improvements in instruments and electrical apparatus have combined to make transurethral resection of certain types of vesical neck obstructions a boon to mankind Every urologist and indeed, every medical practitioner should understand which types of prostatic obstructions are suited to treatment by this method and which are not

*Indications and Contraindications for Transurethral Resection of the Prostate* Transurethral resection is applicable only to a definitely limited set of conditions Within these limits its usefulness has been amply proved Indications for the resection of prostatic obstruction by this route, according to our experience, are (1) intrusion of a slightly or moderately enlarged middle lobe, with or without slight lateral lobe enlargement, (2) slightly or moderately enlarged lateral lobes without median lobe enlargement, (3) subcervical gland hypertrophy causing frequency, (4) certain cases of carcinoma of the prostate with obstruction at the vesical neck, (5) conditions of marked renal impairment, grave heart lesions, or other constitutional disabilities which cannot be removed by suitable preoperative treatment (here the aim must be merely to establish drainage) (6) senile patients unable to undergo open operation Even in this last type of case, if the prostatic obstruction is of a pathological type better handled by open operation, it would be advisable to perform cystostomy and prepare the patient with extra care, then, if the general condition can be made to warrant it, perform a prostatectomy rather than attempt resection by the transurethral route

In addition to the treatment of the foregoing types of prostatic obstructions, transurethral resection has been proved highly satisfactory

for the treatment of median bars (p 842), contractures of the vesical neck (p 1065), and congenital valves of the posterior urethra (p 685)

Many urologists believe that in the treatment of prostatic carcinoma, with obstruction of the vesical neck, transurethral resection combined with radium is the method of choice after the diagnosis has been established. As a diagnostic aid for the detection of malignancy, however, it leaves much to be desired. Tissue removed by the cutting electrode does not lend itself to the preparation of sections as well as that secured by the scalpel. Not only is it difficult to differentiate cell structure which has been in contact with the electrocautery, but, also, the fact that questionable tissue is frequently left behind throws suspicion upon a negative pathological report inasmuch as malignancy may have occurred in the tissues that were not resected. If it be true, as is now generally estimated, that from 15 to 30 per cent of hypertrophied prostates are malignant, these considerations are of great importance.

The ability to decide when a patient should not be subjected to transurethral resection is as important as the possession of the skill requisite to apply the technic when it is indicated. No resection instrument as yet devised is capable of dealing adequately with an advanced degree of prostatic hypertrophy, notwithstanding the fact that many of them have repeatedly been used for this purpose. Extensive enlargement of all the lobes offers an insurmountable barrier to successful transurethral resection. This method should not be employed (1) in the presence of massive median lobe hypertrophy, (2) in marked enlargement of both lateral lobes, even though the median lobe is not enlarged or is shrunken and sclerotic, (3) when the median and lateral lobes are so hypertrophied as to constitute a formidable mass of tissue. In this last type, more than in any other, good surgical judgment is required and experience is the best guide.

Speaking generally, it has been our experience that all untoward results have come to pass because we attempted too large resections. Hemorrhage is much more persistent and difficult to control when a large amount of tissue must be removed, and the operation is rendered a greater risk because of the increased length of time required to resect so large a mass. Most of the instruments in use take very small "bites" so that attempts to remove obstructing lobes of large size have been known to consume more than 2 hours—decidedly too much strain to be placed upon the average subject of urinary retention due to vesical neck obstruction. Moreover, the danger of extravasation, at the time of operation and

postoperatively, is too great when large lateral lobes are resected, due to the thinness of the prostatic capsule ventrally and laterally. Incomplete removal of the devitalized tissue is likely to be followed by infarction over a considerable area, resulting in persistent urinary dysfunction and urinary sepsis.

*Preliminary Preparation of Patient* One reason for the partial and complete failures which often follow transurethral resection is the feeling on the part of both physicians and laity that because the immediate mortality of resection is less, and the period of postoperative disability shorter than in the open operation, the procedure is to be regarded merely as "minor surgery." Consequently, preliminary preparation is neglected, and conditions which, if known, would contraindicate the use of this particular therapy, are not uncovered until too late.

None of the preliminary measures considered essential for one about to undergo perineal or suprapubic prostatectomy should be omitted when it has been decided to operate by way of the urethra. Measurement of the amount of residual urine, blood chemistry and phenol sulphonphthalein tests, urinalysis, and the institution of catheter drainage, if necessary, are just as important as in open operation. Suprapubic cystostomy is rarely necessary, however, for, if conditions are such as to demand gradual decompression or suprapubic cystostomy—residual urine being so large in amount and intrusion of the lateral lobes sufficient to make such drainage imperative—the case, in our judgment, is distinctly unsuited for transurethral resection unless there is malignant growth.

*Preliminary Vasectomy* Most authors regard routine vasectomy as unnecessary, since epididymitis has become an infrequent complication as experience with resection has grown. Before transurethral prostatectomy, we usually perform bilateral vasectomy in older men, but not in those who are still in the period of sexual activity.

*Control of Hemorrhage* As in prostatectomy by either the perineal or suprapubic route the control of hemorrhage constitutes one of the major problems of transurethral resection. For this purpose the electric cautery was early combined with instruments for resection the cystoscopic features of the armament being still later additions. Better control of the cautery feature has greatly reduced the postoperative complications due to the use of too great heat, in particular the sloughing of damaged tissue to which most postoperative hemorrhage is directly attributable. It is advisable to use only low amperage in any form of

galvanocautery excision. When high temperatures are brought into service the effects of the heat are felt considerably beyond the area actually resected. The fluid in the tissues immediately affected is converted into steam which scalds and otherwise traumatizes the surrounding bladder neck. Sloughing, cicatrization and eventually contraction of the tissues follow. These unfortunate sequelae can be obviated by the employment of radiothermy with low amperage. Low heat is just as effective in closing the lumina of the severed blood vessels and as this is the primary purpose in employing the electric current in vesical neck resection there is no reason to use anything fraught with such potential dangers as the high temperatures so often utilized in transurethral resection.

In all the devices now available for electrocautery resection the thermic feature is of course introduced for the purpose of sealing the blood vessels which would otherwise contribute to dangerous or even fatal hemorrhage. The mechanism by which this is accomplished varies considerably. In some heat is used *after* the cutting has been done by the surgeon's knife but under these circumstances too it is advisable to raise the temperature only enough to *close* the vessels not to *cook* them. When electric cutting is done it may or may not have hemostatic effect. Therefore even when the electrocautery knife is used it may be necessary to have recourse to radio heat sufficient to stop the bleeding.

The McCarthy radiogenerator now generally employed does not arc over the surface of the electrode as did the current from the earlier spark gap generators. The rapid carbonization of all machines of the spark gap type does not therefore take place and a highly selective heat is obtainable. If the heat be continued at low amperage after the albumin in the blood vessels has been coagulated the tissues will gradually shrivel down into a mass so hard that neither absorption of septic material nor sloughing can take place while incrustation quickly follows. Rapid absorption and the tissue necrosis which induces sloughing are conditioned by a small soft coagulum.

All too often the condition of the tissues surrounding the site of resection which are left after the excised tissue has been removed is disregarded. Consequently sloughing and secondary hemorrhage in areas outside the actual site of excision and cauterization are of frequent occurrence. While they may not have come in direct contact with the heat of the electrode the steam generated in the tissues which the electrode did touch will scald them seriously and in those devices where

the actual cutting is not done under complete vision there is no guarantee that tissues pierced by the electrode will be entirely removed by the resector, or that trauma will not occur beyond the operative field. Such injuries are frequently minimized or overlooked entirely yet to them must be attributed most of the unsatisfactory results following vesical neck resection by some of the methods now in vogue.

**Resectoscopes** At present, several different types of highly perfected resectors are available (McCarthy—Figs 208 to 211 Stern Davis Caulk,

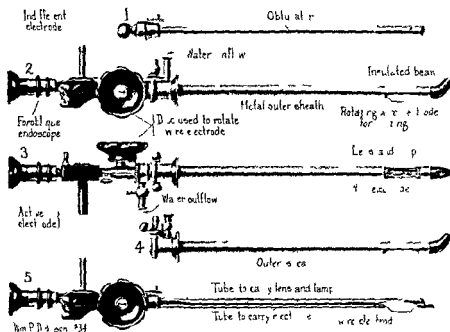


FIG 205 Kirwin resectoscope Component parts and assembled instrument

Bumpus, Collings, Foley, Nesbit, Kirwin), with any one of which it is possible to attain excellent technical results after sufficient practice.

The Kirwin resectoscope, which we use by choice because we have found it to be particularly adaptable to the peculiar needs of vesical neck resection, is illustrated in figures 205 to 207. It is equipped with the McCarthy foroblique telescope, permitting complete vision under all conditions wherein the instrument can be employed. This is a feature of special importance because it is essential that the operator be able to see where the obstruction at the vesical neck is located and at just what point the electrode must be applied in order to secure hemostasis yet not carbonize the tissues. He should also be able to view the resection

to note every movement of the cutting electrode and the precise situation of every bite engaged in the fenestra both before and after it is cut out. Though *cystoscopy with a right angled lens system always precedes resection* this continuous-observation feature is useful and important. The lever which controls the electrode of the Kirwin instrument is attached to a shaft so that it can be rotated in either direction with equal facility. Adapted to the contour of the vesical neck it leaves behind it a smooth

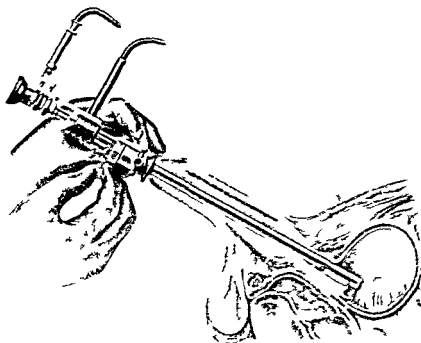


FIG. 206 Kirwin resectoscope. Sectional view showing the instrument in position. The middle lobe has been engaged in the fenestra and the electrode is removing tissue. The left hand holds the instrument in position, the shaft being greatly elevated during resection on the middle lobe. The right hand is grasping the lever and slowly rotating it, thereby causing a rotary motion of the electrode resecting the middle lobe.

cone-shaped orifice. Details of the cutting electrode in figure 205 show how the wire in (3) is directly in the midline and is changing the caliber of the instrument from a No. 28 to a No. 32 of the French scale. This permits the use of a sheath several sizes smaller than would otherwise be possible while obtaining so large a cut and this obviates trauma to narrow urethras. The eccentric swing of the wire electrode at its highest point exceeds the caliber of the sheath by several sizes, permitting removal of sections of dimensions equal to those obtained by large instru-



ments likely to damage the walls of the urethra. This latitude is possible only in a rotary instrument, and greatly increases its usefulness, as well as the scientific precision with which the operation may be carried out.

**Technic of Transurethral Resection of the Prostate** The general principles governing the operation are the same irrespective of which instrument the surgeon may select. The technic here described is that followed when the Kirwin resectoscope is used.

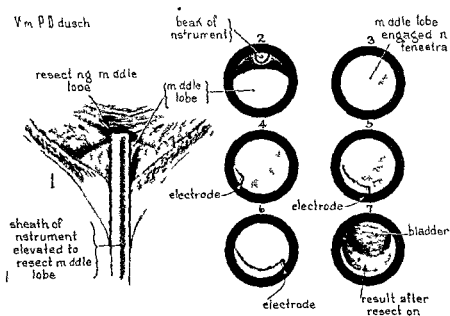


FIG. 207. Kirwin resectoscope. Resecting the middle lobe of the prostate. (1) The bladder at the vesical orifice. The cutting electrode is downward and cannot be seen. In resecting the middle or posterior portion of the vesical orifice the shaft of the instrument must be greatly elevated in order to engage tissue in the fenestra. (2 to 6) Cystoscopic views of resection carried out on the middle lobe. (7) The result after resection showing the bladder and a large groove through the prostate.

With the patient in the lithotomy position the instrument is inserted and the field of resection oriented. The ureteral orifices are first located and the center of the interureteric ridge midway between them ascertained. By withdrawing the instrument somewhat, the precise position of the verumontanum is established. Between these two structures lies the field of resection, and the avoidance of injury to either of them is one of the chief technical points in the entire procedure.

When the median and lateral lobes are all enlarged one of the lateral lobes should be attacked first. Removal of the middle lobe first will cause the two lateral lobes to collapse toward each other, with resulting

difficulty in the control of bleeding and efficient removal of the remaining tissue. If the left lateral lobe is resected first, the shaft of the instrument is carried well to the patient's right side, thus forcing the tissue into the fenestra. When this is accomplished, the beak of the instrument is no longer within the visual range, indicating that the lobe is in position to be resected. The cutting arc passes from left to right. The cut completed, the obturator carrying the cutting electrode is unlocked, rotated, and withdrawn, bringing with it the cut piece of tissue. In this way, a

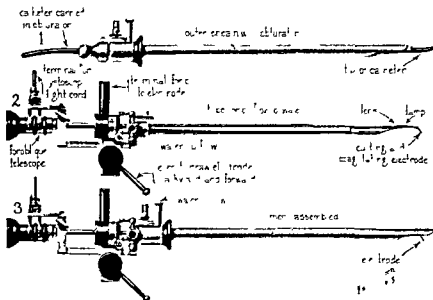


FIG 208 McCarthy resectoscope (1) Outer sheath. (2) Inner unit with cystoscope and cutting electrode (3) Instrument assembled. (Courtesy of Dr Robert W. McKay.)

field clear of debris is insured, and visual evidence of the amount of tissue so far resected is constantly in view. The procedure is repeated on the other lobes until the proper amount of obstructive tissue has been removed—that is, until the operator can see an unobstructed passageway from the verumontanum to the interurethral ridge. The amount of tissue which must be taken out in order to open such a passageway depends not alone on the size of the middle lobe but, even more, upon the amount of lateral lobe intrusion.

The resection completed, a No 24-F Foley self retaining catheter (with 30 cc bag) is introduced into the bladder through the urethra and secured by inflating the bag.

*Postoperative Care* Postoperatively, a urethral catheter is kept in place until all blood has disappeared from the urine—usually a period of from 3 to 5 days. This should be irrigated once a day, as there is a considerable amount of slough which must be kept out of the bladder. A urinary antiseptic is given orally to prevent the rapid growth of bacteria. Sulfadiazine, 0.5 Gm. 4 times a day, has proved particularly useful in preventing or combating non specific infections of the bladder following transurethral prostatectomy.

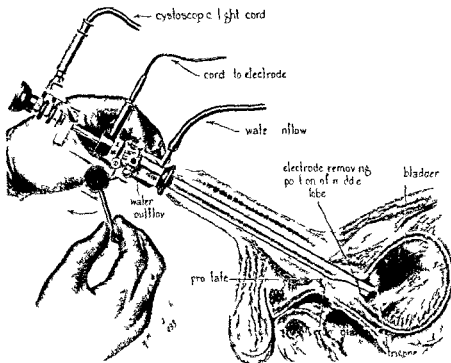


FIG. 209 McCarthy resectoscope. Sagittal section showing use of the McCarthy resectoscope in removing a portion of an enlarged middle lobe of the prostate gland. (Courtesy of Dr. Robert W. McKay.)

*Postoperative Complications* If, despite every care, *postoperative hemorrhage* does occur, pressure should be exerted upon the perineum by packing, the clots evacuated through a large catheter, and the bladder irrigated with silver nitrate, 1:5000. Rarely, it may be necessary to resort to suprapubic cystostomy.

If a Foley hemostatic catheter (which is now widely used after prostatic resection) is in position, the application of traction on the catheter may be all that will be necessary to check the bleeding.

The addition of transurethral prostatectomy to the urologist's armamentarium has not eliminated any of the previous complications of prostatic surgery but has added two, namely, *rupture of the bladder*, a not uncommon occurrence, and *traumatic stricture of the pendulous urethra*, a more remote complication due to too strenuous dilatation of narrow

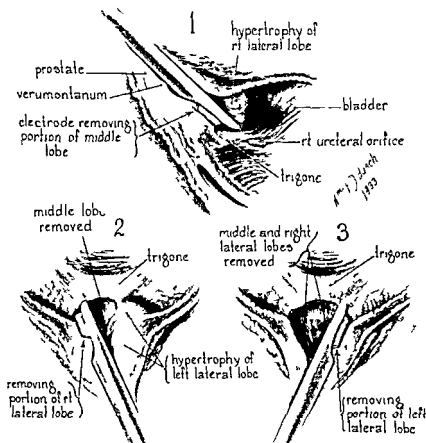


FIG 210 McCarthy resectoscope (1) Shows removal of a portion of the middle lobe (2) Removing a portion of the right lateral lobe (3) Removing a part of the left lateral lobe (Courtesy of Dr Robert W McKay)

urethras in order that they may accommodate the resectoscopes in common usage, most of which are No 28 or 29 F in caliber

#### *Operative Treatment of Carcinoma of the Prostate Gland*

The treatment of prostatic carcinoma depends upon the stage of the disease, the degree of urinary obstruction, and the general condition of

the patient The prognosis at best is poor, and treatment in a majority of cases, in the past, has been palliative rather than curative, although

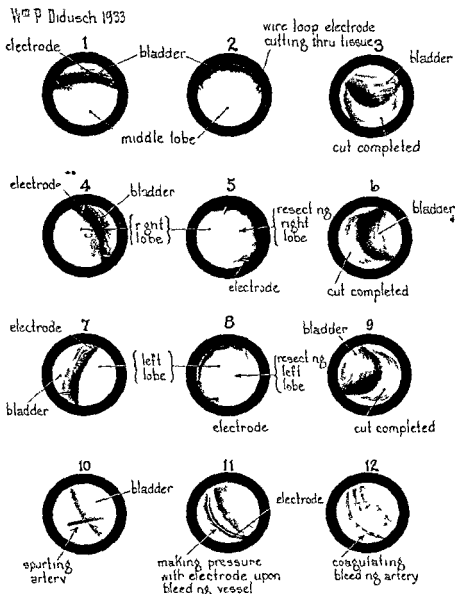


FIG 211 McCarthy resectoscope Series of views as seen through foroblique telescope during prostatic resection (Courtesy of Dr Robert W McKay)

death has sometimes been postponed for years and suffering considerably relieved Only in those cases of prostatic cancer in which the lesion is still confined to the gland is there any hope for cure

The various methods of treatment, and the general indications for their employment, have been considered elsewhere (see Carcinoma of the Prostate Treatment, p 857, Orchidectomy for Carcinoma of the Prostate, p 498, Radium and Roentgen Ray Therapy of the Genito-Urinary Tract Prostate, p 1747)

Total perineal prostatectomy, at present the only curative treatment, is described below

### *Total Perineal Prostatectomy*

Total perineal prostatectomy is an operation which should be done oftener. Its field of usefulness is fairly wide, and it is evident that it is too often neglected by the urological surgeon. In the past, the operation of total, or subtotal prostatectomy has been done almost exclusively for early prostatic malignancy. There are, however, certain other pathological conditions of the prostate in which this operation is occasionally to be preferred to conservative prostatectomy or transurethral resection.

Except in carcinoma, or cases with considerable periprostatitis, complete removal of the prostate with its capsule can usually be done with ease and facility by the well trained surgeon, and offers no great technical difficulties. Total perineal prostatoseminal vesiculectomy for carcinoma is an operation of greater magnitude and difficulty than total prostatectomy for a small fibrous gland or for prostatic calculosis and infection.

*Indications for Total Prostatectomy* Early malignancy of the prostate is the pathological condition which particularly calls for total perineal prostatectomy. Unfortunately, in its early development prostatic carcinoma causes neither pain nor bleeding, therefore, it is seldom discovered in its early state (Carcinoma of the Prostate, p 844). Most cases of carcinoma, when seen by the urologist, are beyond the hope of radical cure, but if the disease is discovered before it has extended beyond the prostatic capsule and the bases of the seminal vesicles total prostatectomy, with removal of the vesicles, offers a chance of cure.

*Chronic pyemia of the prostate* is another condition which may require total prostatectomy. It may be caused by a variety of organisms (Chronic Prostatitis, p 810). Sometimes the prostate becomes so infected that no amount of palliative treatment will effect a cure. Complete removal of the prostate and its capsule then becomes necessary. Transurethral resection is unsatisfactory.

*Chronic tuberculosis of the prostate*, when accompanied by calcium

deposits, should, we believe, be treated by total prostatectomy. On the other hand, in acute or subacute tuberculosis of the prostate operation is distinctly contraindicated.

*Chronic fibrosis of the prostate* should be treated by total prostatectomy. These are small, truly sclerotic prostates, in which the fibrous and muscular elements predominate and in which the glandular hyperplasia is either absent or limited in amount. This group may include certain cases of fibrosis which follows an acute infection, but more common is fibrosis with no history of acute infection. No amount of palliative treatment seems to be effectual in these cases, so total removal of the gland and its capsule is a rapid and effective method of curing the condition. A study of the microscopic sections of such a prostate reveals clearly why this is so. As pointed out by Crabtree nearly a decade ago, the results of the ordinary conservative prostatectomy are not, as a rule, satisfactory, as there is frequently a roughened prostatic cavity, tight internal sphincter, contracted prostatic urethra, persistent infection and continued symptoms. These fibrous prostates should be distinguished from those cases in which prostatic bar alone exists, these, as a rule, require only resection. The preoperative diagnosis of the type of prostate suitable for this operation is sometimes difficult, but as a rule the fibrous prostate can be diagnosed by rectal palpation, cystoscopy, and cysto urethrography.

In certain patients having *adenomatous hypertrophy of the prostate*, who have ceased to have sexual intercourse, it is advisable to do a total prostatectomy because of the possibility of cancer developing in the posterior lobe, which is not removed during a conservative prostatectomy by either the perineal or suprapubic route. If the patient still retains a sexual life total prostatectomy is not recommended as a rule.

*Prostatic calculosis*, in men who have neared the end of sexual life, is a condition for which total prostatectomy should be performed. Younger men, who may have numerous calculi present in their prostates, should be treated by prostatotomy or, in certain cases, by transurethral resection (Operative Treatment of Prostatic Calculi, p. 932).

If the patient still retains a sexual life, total prostatectomy is not recommended as a rule, since in this procedure the ejaculatory ducts are removed and ejaculation cannot occur, which is very distressing to the patient. Exceptions to this are the younger patient with malignancy of the prostate and the patient whose sexual life has become of less importance and whose prostate acts as a focus of infection and a cause

of obstruction. In any event if sexual power has not already been lost due either to age or to the pathology within the prostate the possibility of impotence ensuing should be explained to the patient before operation.

**Technic of Total Perineal Prostatectomy** *Young's Total Prostatectomy for Carcinoma* One cannot discuss the subject of total prostatectomy without paying proper homage to Hugh H. Young who paved the way for all modern perineal prostatectomies. Young's total perineal prostatectomy for carcinoma usually with modifications according to the preference of the individual operator is the operation most commonly used for removal of the malignancy in cases where the disease has not yet extended beyond the prostatic and periprostatic tissues. By this technic it is possible to remove in one piece the prostate with its capsule, the prostatic urethra and a small section of the membranous urethra, a section of the bladder which includes the greater part of the trigone, both seminal vesicles and 6 or 7 cm. of the vas deferens on each side.

**Other Technics** Technics of total (or subtotal) prostatectomy have been published by Crabtree (1930) who particularly advocates this procedure for small fibrous prostates and by Henline (1940) who stresses its suitability in prostatic calculi with infection and fibrosis and with or without adenoma.

**Lowsley-Kilgore Technic of Total Prostatectomy** The patient is given some type of regional anesthesia unless this is specifically contraindicated. He is placed on the table in the exaggerated lithotomy position.

A Lowsley curved prostatic tractor is passed through the urethra into the bladder and its blades opened. The scrotum is retracted anteriorly and a semilunar incision is made in the perineum about 1 inch above the anus. The ischiorectal fossa on each side of the central tendon is opened by blunt dissection, care being taken to avoid dissecting too far laterally as the pudic nerve and vessels are liable to injury. The central tendon is incised behind the point where it is joined in the lateral perineal muscles which permits the central structures to be retracted anteriorly with the lateral perineal muscles. The gloved index finger of the left hand may be placed in the rectum as a safeguard. The dissection is carried above the rectal wall until the apex of the prostate is encountered. At this point will be found the recto-urethralis muscle which is a reflection of the levator ani and attaches the rectum to the urethra. It is incised or pulled to one side exposing the posterior surface of the prostate which is recognized by its glistening fascia of Denonvilliers. The prostate is



further exposed by separating the fibers of the levator ani. This exposure is continued backward until the fascia covering the seminal vesicles is seen. At this point a transverse incision may be made in this fascia which permits greater mobility of the gland later in the procedure. The finger is removed from the rectum, the glove changed, and a piece of gauze is placed over the exposed anterior surface of the rectum.

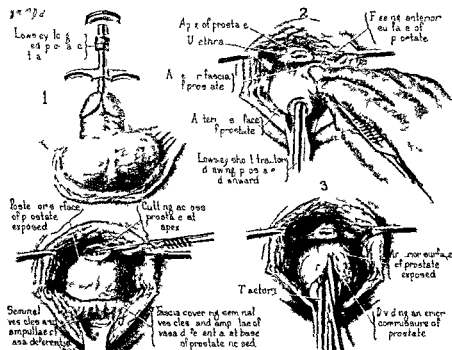


FIG. 212 Lowsley-Kulgoore method of total perineal prostatectomy. (1) The posterior surface of the prostate has been exposed and a transverse incision made in the fascia covering the seminal vesicles. The prostate is being cut across at the apex. (2) The curved prostatic tractor has been removed and the Lowsley short, straight tractor inserted and depressed downward exposing the anterior or commissure. The anterior surface is being freed by blunt dissection. (3) Dividing the anterior commissure in the middle, exposing the prostatic urethra and vesical orifice.

A posterior tractor is then placed in position and a transverse incision is made through the urethra at the apex of the prostate. The curved prostatic tractor is removed and the Lowsley short, straight tractor is passed through the prostatic urethra into the bladder and opened. When the tractor is depressed downward the anterior commissure is exposed. The anterior surface of the prostate is carefully freed from the overlying tissue by blunt dissection, bringing into view the anterior margin of the vesical orifice. The lateral surfaces are next separated from the surrounding structures by blunt dissection.

After the prostate has been mobilized down to the wall of the bladder, the anterior commissure is divided in the midline after the manner suggested by Dr Robert E. Kilgore, exposing the vesical orifice and the

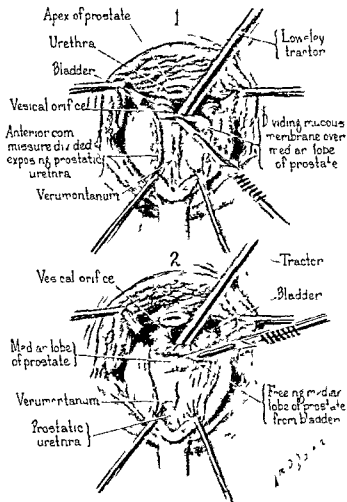


FIG 213 Total perineal prostatectomy (1) The anterior commissure has been divided in the midline exposing the prostatic urethra and the vesical orifice. Incising the mucous membrane over the median lobe of the prostate. (2) Freeing the median lobe from the bladder at the vesical orifice.

prostatic urethra. A transverse incision is then made in the prostatic urethra, just distal to the internal sphincter. If the lateral lobe intrusion is so marked that the internal sphincter cannot be visualized, a

midline incision may be made through the floor of the prostatic urethra, dividing the posterior and median lobes of the gland. This bisects the entire prostate up to the vesical orifice, and by exerting lateral traction

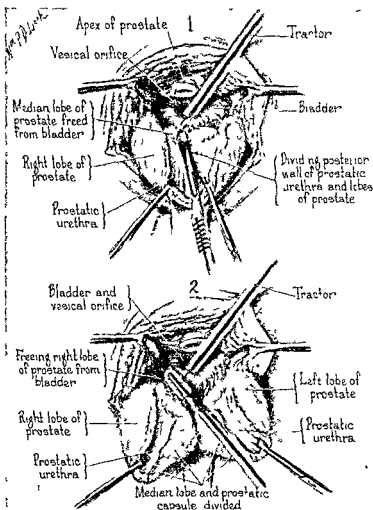


FIG 213(a) Total perineal prostatectomy (1) A midline incision is made in the posterior wall of the prostatic urethra, dividing the median and posterior lobes of the prostate. This bisects the entire gland up to the vesical orifice. (2) By exerting lateral traction on each half, the prostate may now be freed from the floor of the vesical orifice without injury to the vesical sphincter.

on either half of the gland, good exposure is obtained. The prostate may now be freed from the floor of the vesical orifice on both sides under direct vision and with a minimum of trauma to the internal sphincter. As the dissection proceeds downward, a group of vessels will be found

entering the prostate from each of its lateral aspects. These are tied off and cut, thus preventing the excessive hemorrhage which results when this ligature is not placed on each side.

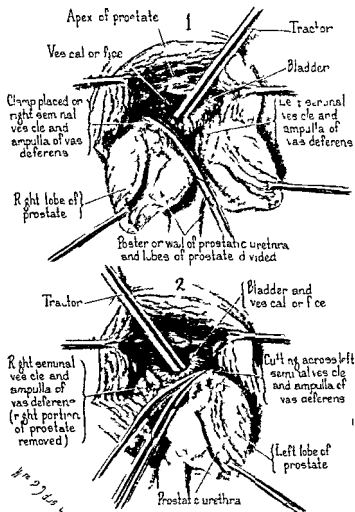


FIG 214 Total perineal prostatectomy. (1) A clamp is placed across the right seminal vesicle and ampulla of the vas deferens. (2) The right lateral lobe of the prostate and part of the median lobe have been removed. A clamp has been placed across the left seminal vesicle and ampulla of the vas and the left half of the prostate is being removed.

Bisecting the prostate allows good exposure of the seminal vesicles so that these may easily be removed, or clamped and ligated with the vasa deferentia and the accompanying blood vessels. If the seminal vesicles are to be removed, the ampulla of the vas on the right side is clamped

and ligated, and the entire right side of the prostate (containing part of the anterior lobe, the right lateral lobe, and part of the posterior lobe),

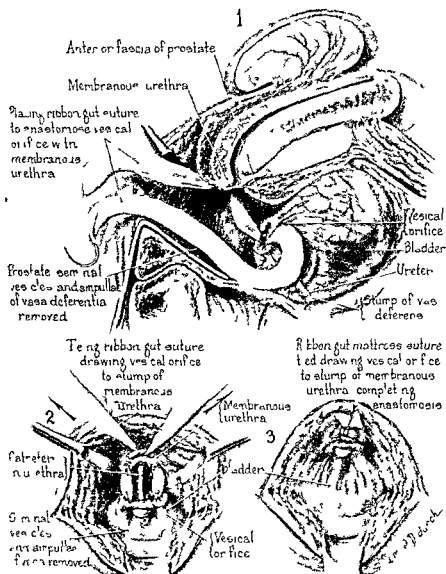


FIG 215 Total perineal prostatectomy. Repair of vesical orifice and urethra with chromic ribbon gut. (1) Sagittal section showing the method of placing the ribbon gut suture to anastomose the vesical orifice with the membranous urethra. (2) Tying the suture to complete the anastomosis. A Foley catheter has been inserted through the urethra into the bladder. (3) Showing the ribbon gut suture tied, anastomosis completed and the continuity of the urinary canal re-established.

the right seminal vesicle, and part of the ampulla of the vas are removed in one mass. A similar procedure is followed on the left side.

A No 24 F Foley catheter is then passed through the urethra and into the bladder

The cut end of the membranous urethra and the bladder neck are now separated by a considerable space which formerly was occupied by the prostate gland

The repair is accomplished by passing a chromic ribbon gut suture through the wall of the urethra and carrying it to the inside of the vesical

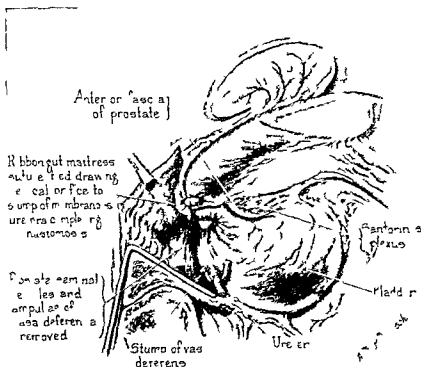


FIG 216 Total prostatectomy. Sagittal section showing completed anastomosis of vesical orifice to stump of membranous urethra. This one ribbon gut suture (1) controls bleeding making packing or a bag unnecessary (2) approximates the vesical orifice to the urethra re-establishing the urinary canal, and (3) plicates the urethra reducing incontinence to a minimum

orifice over behind the apex of the trigonum vesicae into the bladder lumen again and then to the outside of the urethral wall. The two ends are then tied tightly. This one suture accomplishes several things. It (1) acts as a hemostatic agent for all the cut edges (2) approximates the vesical orifice to the urethra over a catheter making the urethral lumen continuous with that of the bladder and (3) plicates the urethra, reducing incontinence to a minimum. A second ribbon-gut suture is

inserted into the left wall of the urethra, carried over the apex of the trigonum, and through the right wall of the urethra, and is then tied, reinforcing the first plication suture

The Foley catheter is fixed in position by injecting the retaining bag, and the bladder is irrigated. One short Penrose drain is placed over the wall of the rectum, and the wound is closed by approximating the levator ani muscles with one or two chromic catgut sutures, and the subcutaneous tissue and skin with interrupted silk or dermal Stewart sutures

Our results with this technic have been far better than with any of the methods of total or subtotal prostatectomy formerly used by us. By removing the capsule postoperative hemorrhage is obviated, as the vessels leading to the capsule are tied off. Patients are usually out of bed within a week, and their wounds heal promptly. Various manipulations, such as passing sounds and catheters, are much more easily accomplished than is possible by conservative perineal or suprapubic prostatectomy as there is no cavity in which the instrument may get lost. Control of urination is much better than one sees in the average perineal prostatectomy

### *Operative Treatment of Prostatic Abscess*

Evacuation of a prostatic abscess may be accomplished by one of several methods. The most satisfactory method is surgical evacuation through the perineum, either by exposure of the prostate and prostatectomy, or by external urethrotomy, as the circumstances may dictate

The transvesical route is occasionally employed, but our own experience with this has not been encouraging. In general, any breach of the abdominal wall is to be avoided if a less extensive procedure can be made to serve

Barringer's method of aspiration through the perineum, with the finger in the rectum as a guide, is unsatisfactory as drainage is incomplete and the procedure must usually be followed by open operation

**Evacuation of Prostatic Abscess through Posterior Urethra** This method is preferable when there is a strictured urethra

A Lowsley prostatic tractor is introduced into the urethra and a midline incision made in the perineum (Figs 217 and 218). The bulbous urethra is exposed and incised longitudinally upon the retractor. The finger is inserted through the urethral incision into the prostatic urethra, and then through the wall of the prostatic urethra into the abscess

cavity to assist in the evacuation of the pus. If the area of suppuration consists of several pockets, it may be necessary to break down the inter-

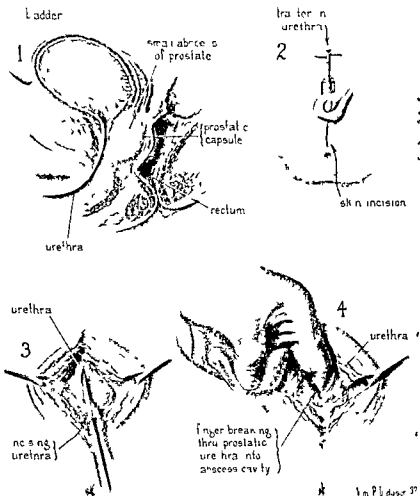


FIG. 217. Evacuation of a small prostatic abscess through the posterior urethra. (1) Sagittal view showing a small abscess of the prostate. The abscess causes a slight bulging into the rectum and the capsule has become thinned out by the pressure from within. (2) A tractor or sound is introduced into the urethra and a midline incision made in the perineum. (3) The urethra is exposed and incised upon the retractor. (4) The finger is inserted into the prostatic urethra and breaks through the urethral wall into the abscess cavity evacuating it.

vening septa, after which all the cavities should be thoroughly irrigated. A drainage tube is then inserted through the urethrotomy incision to divert the urine and conduct the pus out through the perineal wound.



Recently we have been placing sterile sulfathiazole or sulfadiazine powder in surgically drained abscesses with very beneficial results

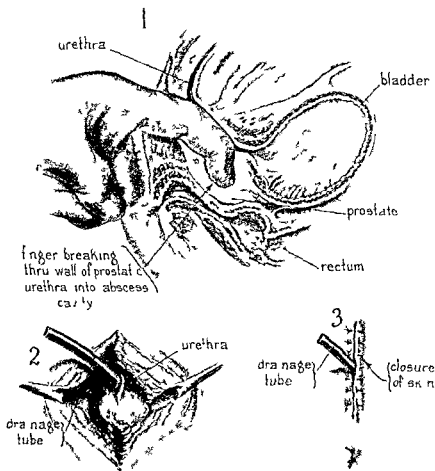


FIG 218 Evacuation of small prostatic abscess through the posterior urethra (1) Sagittal view showing the finger breaking through the wall of the prostatic urethra into the abscess cavity (2) A drainage tube is inserted into the urethra and secured in position (3) The skin is closed with interrupted mattress sutures

**Evacuation of Prostatic Abscess from Outside the Urethra (Prostatotomy)** This method is preferable when there is no stricture of the urethra and particularly when the abscess occupies the posterior lobe of the prostate

A tractor or sound is inserted into the urethra, by means of which it is possible to ascertain the exact location of the bulb. Through an inverted V incision in the perineum the intervening tissues are carefully dissected apart until the suppurating prostate is exposed to view. It is then possible to see in which direction the abscess is pointing and to either incise and evacuate it (Fig. 219) or, if the tissues are badly damaged, do a partial prostatectomy. A drainage tube is inserted through the incision in the prostate and the skin sutured about it.

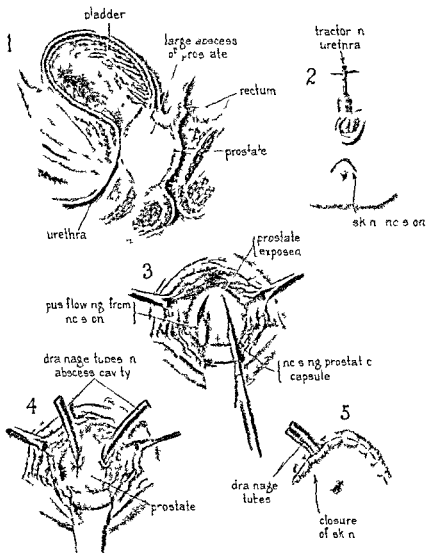
**After-care.** The patient should be observed for some time postoperatively. Chronic prostatitis is often present in cases of prostatic abscess and this must be treated by the proper measures.

### *Operative Treatment of Prostatic Calculi*

Prostatic calculi are, as a rule, small and multiple, and frequently exist for years without producing symptoms, being discovered accidentally during routine examination (Calculus of the Prostate Gland, p. 866). In such cases, no treatment is required. When symptoms of obstruction or infection occur, and are found to be due to the presence of the calculi in the prostate, surgical intervention becomes necessary.

In older men who have neared the end of sexual life we prefer to treat prostatic calculosis by removal of the prostate with its capsule both when there is associated adenomatous hypertrophy of the prostate and when there is no hypertrophy but infection and fibrosis are present (Total Perineal Prostatectomy, p. 920). When there is associated adenoma, the calculi will be found embedded between the hypertrophied area and the prostatic capsule having been pushed toward the capsule by the developing adenoma. In cases of multiple calculi without hypertrophy, there is often associated fibrosis and infection and the capsule and infected prostatic tissue are so closely adherent as to make a clean separation between them impossible. Prostatotomy, transurethral resection, and even the usual conservative perineal or suprapubic prostatectomy frequently leave enough calculi or infected prostate to cause persistence or recurrence of symptoms. The presence of such residual stones, following all of these procedures, has been repeatedly demonstrated by roentgenograms taken postoperatively. To completely remove all calculi, as well as infected prostatic tissue it is necessary to remove the prostate together with its capsule and we believe that this should be done when sexual power has been lost either because of age or by reason of the pathology within the prostate.

Younger men with numerous stones in their prostates should be treated by prostatotomy as a rule. The prostate may be exposed through the



J. Wm. P. D. Dorsch 1932

FIG 219 Evacuation of a large prostatic abscess from outside the urethra. (1) Sagittal view showing large prostatic abscess with marked bulging into the rectum and thinning of the prostatic capsule. (2) A tractor is introduced into the urethra and an inverted V incision made in the perineum. (3) The prostate is exposed as in perineal prostatectomy and two parallel incisions made in its posterior surface. Pus can be seen flowing from the right incision. (4) A drainage tube is inserted in each side of the prostate and brought out through the capsular incisions, being secured in position by a single suture placed in the capsule. (5) The skin is closed by mattress sutures, the drainage tubes being brought out on the right side.

perineum, and the calculi removed with a curette, with as little destruction of prostatic tissue as possible

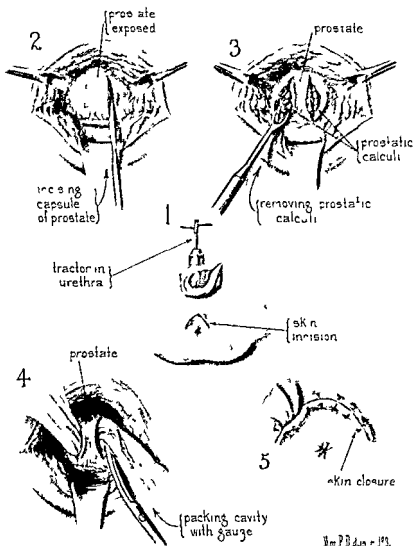


FIG. 220 Prostatotomy for the removal of calculi. (1) A prostatic tractor having been placed in the urethra an inverted V incision is made in the perineum. (2) The prostate is exposed as in perineal prostatectomy and two parallel incisions made in the posterior capsule. (3) Removing the calculi with a scoop. (4) After removal of the stones the cavities in the prostate are packed with gauze. (5) The skin is closed with mattress sutures the gauze being brought out on the right side.

If there is slight subcervical group enlargement associated with the calculi, the subcervical group of tubules and the stones may be removed

with the resectoscope Transurethral prostatic resection is also frequently employed when calculi are present without associated hypertrophy Since it does not result in impotence or sterility, it is regarded as especially applicable to younger men It has, however, the disadvantage that calculi are often left behind in the prostate, so that infection frequently persists and relief is only temporary

#### *Other Surgical Considerations in the Treatment of Prostatic Pathology*

There are several other pathological conditions of the prostate gland that occasionally require surgical intervention but which have already been adequately considered in the preceding chapter tuberculosis of the prostate (p 821), cysts of the prostate (p 824), sarcoma (p 860), and median bar (p 842)

### B NON OPERATIVE TREATMENT OF THE PROSTATE GLAND

Non operative measures that have proved helpful in the treatment of various prostatic conditions include urethral dilatations, prostatic massage, the application of heat to the prostate by various means, urethral instillations, urethrovesical irrigations, vaccines and bacteriophage, diet, sedative medication, chemotherapy, hyperpyrexia (p 726), and hormonal therapy (p 840) The use of ultra violet ray or quartz light therapy has also proved beneficial in certain obstinate cases of chronic prostatitis Radiotherapy of prostatic malignancy is described on p 1747, and deep x-ray therapy of benign hyperplasia on p 1745

#### *Prostatic Massage*

The indications for the use of prostatic massage have been discussed in the preceding pages

The technic, as well as the results obtained, vary widely with different operators Some merely stroke and rub the perineum, while others place the thumb upon the prostate, as palpated through the perineum and the index finger upon its rectal aspect, kneading the gland between the two digits

The patient may stand with the body bent forward, as over the back of a chair, with his heels separated and his toes turned slightly inward to insure a firm stand, or he may rest upon his knees and elbows We prefer the latter position The operator, with his gloved index finger in the rectum, exerts gentle but firm pressure upon the lobes palpable from that position, using a downward stroking motion with the force directed toward the urethra, the object being to empty the prostatic acini of their purulent contents and to break up adhesions about the

gland It is continued until the entire portion of the prostate palpable from the rectum has been covered Secretions later may be expressed from the ejaculatory ducts and the sinus pocularis by bringing the firmly pressing finger downward along the posterior urethra.

*The bimanual method*, the other hand exerting counter pressure above the symphysis is considered more effectual by some operators, especially when it is desired to strip the seminal vesicles as well

Most patients with chronic prostatitis are benefited by intelligent application of prostatic massage, but too vigorous, or unduly prolonged or too frequent massage may cause unfavorable reactions The degree of pressure is a matter of experience and judgment and is governed largely by the degree of inflammation present The massage must be firm enough to express the infected secretion As a rule, massage is carried out twice a week at first As the patient's condition improves the treatments taper off, so that he receives massage once a week, then every 10 days, semi monthly, and finally once a month Frequent microscopic examinations of the unstained prostatic fluid should be made, as the results of treatment can be best ascertained in this way

Caution must be observed at all times Acute epididymitis which follows too vigorous or too early prostatic massage, is a distressing complication for which the operator is frequently blamed by the patient

#### *Heat Producing Methods in the Treatment of Prostatic Disease*

Raising the temperature of the acutely or chronically inflamed prostate has definite therapeutic value There are many methods of applying heat to this region

Relief may often be obtained by hot sitz baths (110°F) night and morning, or by hot rectal irrigations, properly applied Two or three irrigations a day will usually bring relief of the irritation and swelling in a few days, or even sooner, in the acute cases The rectum is capable of tolerating a high degree of heat—110°F to 120°F The temperature of the solution (water, saline or sodium bicarbonate, 1 to 5 per cent) may be started at 110°F and gradually increased to 120°F

Diathermy and radiothermy are both helpful in many prostatic conditions The greatest elevation of temperature is obtained with the use of a water cooled official electrode Some patients, however, find the application of the electrode undesirable, and some cannot tolerate it

Heat may be applied to the prostatic urethra prostate, and vesical

orifice under vision by means of instruments such as the cysto-urethroscope devised by Lowsley. This has a large electrode by means of which heat may be applied in such a degree that vigorous drainage of the prostate and vesical neck results.

The Elliott treatment regulator is an effective method of treatment and offers a means of applying dry heat, at any desired temperature and pressure, directly to the prostate gland and adjacent structures. The apparatus is introduced through the rectum

### *Vaccines and Bacteriophage*

Vaccines—autogenous and prepared—and bacteriophage have a limited usefulness in the treatment of prostatic infections. In our practice, we have found vaccines very helpful in certain cases of arthritis where the infective focus was located in the prostate, but in other cases their use has resulted in no appreciable benefit to the patient.

### *Urethrovessical Irrigations*

Urethrovessical irrigations with mild antiseptic solutions should always accompany prostatic massage. Such irrigations not only cleanse the posterior urethra of the products evacuated during massage, but relieve the infection of the bladder and bladder neck that is often present. The solutions most frequently employed are. rivanol dextrose, 1:5,000, acriflavine, 1:5,000, potassium permanganate, 1:8,000, and silver nitrate, 1:10,000.

### *Sedative Medication*

When there is pain in the region of the prostate or during micturition, the patient should be given a soothing prescription, such as Kirwin's mixture:

Potassium citrate	Drams VI (24 cc.)
Tinct. Hyoscyami	Ounces I (30 cc.)
Tinct. Opi camphorata	Ounces I (30 cc.)
Elx. Saw palmetto et Santalwood q.s. ad	Ounces IV (120 cc.)
Sig —Drams II (8 cc.) q 4 hours	

When prostatic pain is very severe, sedatives are often necessary for its relief. Sedative suppositories (opium and belladonna) or the barbiturates orally usually suffice, but occasionally it may be necessary to give codeine, pantopon, or morphine.

*Diet in the Treatment of Prostatic Conditions*

Marked irritation of the bladder is a common accompaniment of prostatic diseases. In such cases a restricted diet is recommended. Adequate vitamin intake is important.

In the Brady restricted diet used by us for patients with bladder irritation the following foods are eliminated from the general diet:

Meat	All meats except one serving daily of lamb, fish, poultry, or bacon
Soup	Meat broths
Vegetable	Asparagus, tomatoes, broccoli, peppers, sauerkraut, watercress
Fruit	Grapes, apricots, berries, cherries, plums, prunes, cranberries, rhubarb
Beverage	Excessive amounts of tea and coffee, alcohol
Miscellaneous	Fried foods, condiments

This diet contains approximately 65 Gm. protein, 90 Gm. fat, 245 Gm. carbohydrate (2100 calories).

*(Sample Outline)*

MORNING	NOON	NIGHT
Fruit	Meat	Cream soup
Cereal	Potato	Crackers
Toast	Vegetable	Eggs or cheese dish
Butter	Dessert	Vegetable
Milk	Bread	Salad
Cream	Butter	Dessert
Coffee	Milk	Bread
Sugar		Butter
		Milk

*Chemotherapy*

Chemotherapy had little curative value in the treatment of prostatic infection until the introduction of the sulfonamide drugs. These drugs have definitely proved their usefulness (1) in shortening the acute stage of prostatic infections, both specific and non specific; (2) in helping to clear up chronic infections; and (3) in combating preoperatively and postoperatively, non specific bladder infections in patients undergoing transurethral resection.

Both sulfathiazole and sulfadiazine are of proved superior value in combating the more common types of infections affecting the prostate gland, namely, those due to the gonococcus, *Staphylococcus aureus* and *albus*, *Bacillus coli* and *Bacillus proteus*. Because of their efficacy and



greater tolerability, they have largely supplanted sulfanilamide and sulfapyridine. However, sulfanilamide is still the most efficient drug in the infrequent infections due to the *Streptococcus hemolyticus*.

It is our practice to give fairly small doses of sulfathiazole or sulfadiazine, usually 2 Gm daily (in 4 doses) for from 6 to 10 days, if tolerated well by the patient. The simultaneous administration of an alkali (such as sodium bicarbonate or Kalak water) is advisable in order to decrease the tendency to the formation of crystals in the urine (see p 1171). In chronic infections, a second course is often given after the lapse of a week or two. Additional short courses, at fairly frequent intervals, may be given when necessary, provided the patient is kept under close observation. The use of a sulfonamide drug should never be continued indefinitely. As a rule, if the patient shows no response to treatment within 10 days, the drug should be discontinued.

In cases of impending abscess we give larger doses (3 to 4 Gm, or even more, daily). In these cases we hospitalize the patients and examine the urine for crystals and keep a careful check on the blood count.

For the occasional patient who cannot tolerate the sulfonamides or is unbenefited by sulfatherapy, methenamine or mandelic acid may be tried. Both of these drugs are of definite usefulness as urinary antiseptics, but their usefulness is limited by their dependence for action on a certain degree of urinary acidity and the necessary concentration of the bactericidal substance in the urine.

Methenamine is of value in both colon bacillus and staphylococcal infections. Since it acts only in an acid urine, the administration of an acidifying drug is necessary. The methenamine and acid sodium phosphate, or other acidifier, must be given in sufficiently large doses—not less than 4 gm of each daily, in divided doses.

Mandelic acid has been found satisfactory by many urologists for combating colon bacillus infections of the prostate gland, although it has now been largely superseded by the use of the sulfonamides. The urine must be kept below a pH of 5.5 for full therapeutic response, and fluids should be limited to 1,200 cc a day. Daily testing of the urine and close observation of the patient are necessary. When administered in the form of ammonium mandelate, a secondary acidifying drug is unnecessary, but when sodium mandelate is used, acid sodium phosphate or other acidifier is required. The dosage is usually 2 Gm of the drug 3 times a day, continued for 6 to 8 days.

Penicillin, our newest and it would appear, most powerful bactericidal

weapon, was first used on human patients in 1941, but it has already demonstrated, experimentally and clinically, its marked superiority to even the sulfa drugs in infections due to the gonococcus, streptococci, and pneumococci. It is a tremendously potent weapon against staphylococci. However, penicillin has one great drawback: it is exceedingly difficult to produce, and the small supplies at present available prohibit its use except in the most desperate of cases. Present evidence indicates that if production of this remarkable drug can be speeded up so as to permit its widespread use in civilian as well as in military medicine, penicillin will eventually revolutionize the chemotherapy of infections including those of the prostate and other organs of the genito-urinary tract, to an even greater extent than have the sulfonamide drugs.

Methenamine, mandelic acid, and penicillin are further considered on pages 1177-1187.

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## INDEX

In the index references to the illustrations are marked by the letters "III".  
Unmarked references are to the text. All references are to page numbers

- Abscess, follicular**, 12, 644, 710  
     inguinolabial, 585  
     of Bartholin's gland, 760, 761, 762  
     *Cowper's gland*, 713, 738, 739  
     kidney, actinomycotic, 1527, III 1526  
     incision and drainage of, 1686  
     staphylococcic cortical, 1453, 1460, 1481  
     tuberculous, 1496, III 1495, 1497  
     prostate, 808, 809, 811, 813, 818, III 808  
     operative treatment of, 819, 929, III 930, 931, 933  
     scrotum, 423  
     incision and drainage of, 423, III 423  
     seminal vesicle, 548  
     treatment of, 550  
     Skene's gland, 760, 761, 762, 782  
     urethra, male, 644  
     treatment of, 645  
     paranepritic, 1480  
     paraurethral, 710, 711, 713  
     perinepritic, 1455, 1480, 1497, 1510  
     diagnosis of, 1484, 1630  
     operative treatment of, 1460, 1485, 1689  
     periurethral, in female, 758, 760, 761  
     male, 645, 710, 713  
     excision of, 646, III 646  
     fistula resulting from, 647, III 647  
     retroperitoneal, 1481, III 1481, 1482
- Absence, congenital, of bladder**, 958  
     kidney, 1362  
     penis, 230, 615  
     prostate, 800  
     seminal vesicle, 526  
     testicle, 376  
     urethra, female, 751  
     male, 615  
     vagina, 577
- Accessory urethra, male**, 626, III 627  
     excision of, 628, 696, III 694  
     urinary meatus, 628
- Acetonuria**, test for, 32
- Acid ash diet** (see Diet)
- Actinomycosis of bladder**, 1035  
     kidney, 1525, 1631, III 1526  
     etiology of, 1526  
     treatment of, 1529  
     ureter, 1249
- Adenocarcinoma of Bartholin's gland**, 590, 1740  
     bladder, 1042, 1055  
     arising in urachus, 1059  
     kidney, 1564, 1760, III 1564  
     prostate, 847, III 848, 849  
     Skene's gland, 769  
     testicle, 454, 461
- Adenoma of adrenal cortex**, 1576  
     bladder, 1045, 1060  
     kidney, 1566  
     urethra, male, 648
- Adenomyoma of vagina**, 599  
     vulva, 590
- Adherent clitoris**, 577  
     penis, 225, 230, 233  
     prepuce, 225, 233
- Adrenal gland, adenoma of**, 1576  
     carcinoma of, 1576  
     ganglioneuroma of, 1580  
     hyperplasia of, 1576  
     neuroblastoma of, 1579  
     pheochromocytoma of, 1580  
     structure and function of, 1575
- Aerogram of bladder**, 174, 1056, 1084
- Albarran's experimental polyuria test**, 50  
     glands, 792, 799, 831, 842, 934  
     method of ureteral anastomosis, 1317
- Albumin in urine, tests for**, 30
- Alkaline ash diet** (see Diet)
- encrusted cystitis**, 999, 1011, 1050, Plate II  
     treatment of, 1012
- Ambard's excretion retention test of renal function**, 62  
     McLean's modification of, 62
- Amebic cystitis**, 1036
- Ampulla of vas deferens**, 521, 523, 525  
     calcification of, 532, III 534
- Amputation of penis for carcinoma**, 303, 323, 656, 657  
     complete, 331, III 324-331  
     partial, 332  
     postoperative care following, 333  
     redundant scrotum, 513
- Amyloid nephrosis**, 29, 1432
- Anastomosis of ureter**, 1304, 1316, 1320  
     Albarran's method of, 1317  
     Curtis's method of, 1318  
     Poggi's method of, 1317  
     vas deferens, 559, III 559  
     uretero-intestinal, 1324  
     Coffey's technics of, 1326, 1329  
     Higgin's technic of, 1330

- Anastomosis, uretero-intestinal, Hutchins'**  
     technic of, 1334  
     indications for, 1123, 1133, 1324  
     Jewett's method of, 1331  
     postoperative care following, 1169, 1335  
     preoperative preparation for, 1169, 1335  
     remote results of, 1337
- Anatomy of bladder, 946**  
     Cowper's gland, 734  
     ejaculatory duct, 523, 524, 525  
     epididymis, 370  
     female external genitalia, 571  
     kidney, 1350  
     penis, 226  
     prostate, 792  
     scrotum, 365  
     seminal vesicle, 524  
     spermatic cord, 373  
     testicle, 367  
     ureter, 1210  
     urethra, female, 749  
         male, 226, 610  
     vas deferens, 522
- Andrew's 'bottle' operation for hydrocele, 512**
- Anephrogenesis, 1362**
- Anesthesia, caudal (see Anesthesia, sacral)**  
     for children, 100, 122, 197, 217, 318, 319  
     circumcision, 319  
     operations upon bladder, 218, 1102  
         Cowper's gland, 218, 743  
         female external genitalia, 602  
         kidney, 219, 1600  
         penis, 217, 318, 319  
         prostate, 218, 878  
         scrotum and scrotal contents, 218, 486  
         seminal vesicle, 218, 560  
         ureter, 219, 1302  
         urethra, female, 217, 781  
             male, 217, 672  
         vas deferens, 218, 556  
     urethral instrumentation, 72, 100, 113, 122  
     general inhalation, 190, 192, 318, 319  
     as supplement to regional anesthesia, 192, 878  
     in urology, discussion and summary of, 190, 217  
     intravenous, 215, 216, 217, 318  
     local, for intraurethral procedures, 72, 101, 113, 213  
     local infiltration, 212, 318  
     paravertebral, 208  
     rectal, with avertin, 197  
     sacral and parasacral, 209, 879  
         care of patient after, 212  
         technic of, 210  
     sedative medication preliminary to, 191  
     segmental penderal, 206  
     spinal, 199, 878  
         care of patient after, 212  
         continuous (fractional) method of, 205  
         preventing undesirable sequelae of, 202  
         technic of, 201
- Aneurysm of renal artery, 1412, 1581, III, 1443**  
     diagnosis of, 1582  
     treatment of, 1583
- Angioma of epididymis, 465**  
     penis, 298  
     renal pelvis, 1546  
     urethra, male, 649
- Angulation and kinks of ureter, 136, 151, 154, 1219, 1222, 1223, 1224, 1294, 1627, III 153**  
     etiology of, 1277  
     treatment of, 1279
- Animal inoculation tests of urine, 42**
- Anomalous, congenital, of bladder, 957**  
     Cowper's gland, 736  
     ejaculatory duct, 526  
     epididymis, 384  
     female external genitalia, 381, 576  
     kidney, 145, 1361, 1408, III 147-149  
         operative treatment of, 1689  
     penis, 229  
     prostate, 800  
     renal blood vessels, 1382  
         in ectopic kidney, 1381  
         fused kidney, 1374  
     obstructing ureteropelvic junction, 1224, 1272, 1279, 1280, 1283, 1309, 1409  
         operative treatment of, 1312  
     scrotum, 375  
     seminal vesicle, 526  
     testicle, 376  
     urachus, 964  
     ureter, 145, 1213  
         operative treatment of, 1225, 1302  
     urethra, female, 751  
         male, 102, 615  
     vagina, 577  
     vas deferens, 526
- Anorchidism, 376**
- Antipenstasis of ureter, 1228**
- Anuria, 7, 908, 980, 1433**  
     due to sulfonamide therapy, 1171  
     ureteral calculus, 1267, 1270  
     hemoglobinuria, 7  
     postoperative, 786
- Aplasia, renal, 1371**
- Arteries of bladder, 955**  
     Cowper's gland, 735  
     epididymis, 370  
     kidney, 1345, 1349, 1357  
         anomalous, 1224, 1272, 1283, 1309, 1374, 1381, 1382  
     penis, 228, 356  
     prostate, 796  
     scrotum, 366  
     seminal vesicle, 525  
     testicle, 370  
     ureter, 1212  
     urethra, female, 750  
     vas deferens, 524
- Arteriography, renal, 171**
- Aschheim Zondek test (see Hormonal test)**

- Aspiration and injection of hydrocele, 471, 511  
 renal cyst, 1544, 1688  
 spermatocele, 511
- Asymmetrical fused kidney (see Fused kidney)
- Atomic bladder, 998, 1087  
 treatment of, 1088, 1160  
 ureter, 136, 1228, 1291, 1412  
 treatment of, 1293
- Atresia of hymen, 578, 600  
 urethra, male, 616  
 urinary meatus, 616  
 vagina, 577, 581, 593, 598
- Atrophy of kidney, 1371, 1416, 1486, 1487  
 testicle, 371, 379, 388, 409, 413, 434, 435, 473, 475
- Autolysis of testicle, 410
- Automatic tidal drainage of bladder, 1160  
 uses of, 1161
- Bacteriological tests of urine, 23, 41, 42, 120
- Bacteriophage therapy, 1718  
 of bladder, 1195, 1718  
 kidney, 1473, 1718  
 prostate, 817, 937  
 seminal vesicle, 546, 567
- Balanitis, 256, 710, 711  
 erosive and gangrenous, 259, 264  
 treatment of, 261
- Balanoposthitis, 234, 256, 710, 711
- Ballotement, renal, 14
- Bartholin's glands, 576, 765  
 abscess of, 760, 761, 762  
 adenocarcinoma of, 590, 1740  
 cysts of, 589  
 extirpation of, 603, 764
- Bas fond of bladder, 835, 949
- Belt's approach in perineal prostatectomy, 898
- Benedict's test for urine sugar, 31
- Benign tumors (see Tumors)
- Bifurcation of ureter, 150, 1214, 1215, 1221, 1224, 1257, III 149, 1366  
 operative treatment of, 1225, 1302
- Bigelow lithotrite, 375, 1126
- Bilharziasis, etiology of, 1031  
 of bladder, 118, 1030, 1030, III 1031  
 treatment of, 1034  
 kidney, 1525  
 prostate, 825  
 ureter, 1248
- Bilobate scrotum, 375
- Bisection of kidney, 1684
- Bladder, 943, 986, 1102  
 absence, congenital, of, 958  
 actinomycosis of, 1035  
 adenocarcinoma of, 1042, 1055  
 arising in urachus, 1059  
 adenoma of, 1045, 1060  
 aerogram of, 174, 1056, 1084  
 anatomy of, 946  
 anesthesia for operations upon, 218, 1102  
 anomalies, congenital, of, 957  
 arteries of, 955  
 atonic, 998, 1087, 1088, 1160  
 attachments of, 946  
 automatic tidal drainage of, 1160  
 bacteriophage therapy of, 1195, 1718  
 bas fond of, 835, 949  
 bilharziasis of, 118, 1030, 1034, 1050, III 1031  
 blood supply of, 955  
 calculus (see Calculus)  
 carcinoma of (see Carcinoma)  
 cord, 1086, 1087, 1088, 1135, 1160  
 cystoscopic appearance of, in disease, 116  
 inspection of, 115  
 decompression, gradual, 883, 1159  
 diet in treatment of, 1006, 1007, 1008, 1187, 1198  
 diseases of, 994, 1092  
 diverticulum of, (see Diverticulum)  
 drainage, suprapubic, of, 1150 III 1150  
 duplication of, 958  
 echinococcus infestation of, 1035  
 embryology of, 943  
 entamebae histolytica infection of, 1036  
 exstrophy of, 237, 579, 960, 963, 964, 1050, 1092, III 961  
 operative treatment of, 1123, 1324  
 fibroma of, 1047  
 fistula of, 118, 994, 1076, Plate V II  
 communicating with bowel, 1077  
 uterus, 1079  
 vagina, 581, 756, 994, 1076  
 operative treatment of, 1128, 1324  
 III 1130-1134  
 foreign body in, 117, 1073  
 removal of, 1075, 1124, III 1074  
 fulguration of (see Fulguration)  
 follow up after surgery of, 1157  
 gangrene of, 999, 1008, 1010  
 gonorrhea of, 761, 1022, III 1022, 1023  
 gumma of, 1023, 1025, 1026  
 hemangioma of, 1048, 1093  
 herniation of, 1061  
 hour glass, 959  
 Hunner's ulcer of, 1013, 1018, 1113  
 hypertonic, 980, 1087, 1160  
 hypotonic, 980  
 incisions for approaching, 1104  
 inflammations of (see Cystitis)  
 injuries of, 118, 179, 918, 986  
 innervation of, 951, 952, 955, 969, 1134  
 irrigations and instillations of, 885, 937, 1007, 1158, 1159, 1197  
 leiomyoma of, 1047  
 leukoplakia of, 116, 1019, 1021, 1041, 1117, Plate II  
 localized submucous fibrosis of, 1013, 1018, 1113  
 malakoplakia of, 1021  
 musculature of, 945, 948, 950, 952, 968  
 myoma of, 1047  
 myxoma of, 1047  
 neurofibromatosis of, 1048

- Bladder, neurogenic abnormalities of, 978,  
979, 1085, 1161  
treatment of, 1088  
non-operative treatment of, 1158  
normal, cystographic appearance of, 177  
cystoscopic appearance of, 115, Plate I  
operative treatment of, 1102  
orifice of (see Vesical orifice)  
palpation and percussion of, 15  
papilloma and papillomatosis of, 118,  
1039, 1050, 1051, 1057, 1060,  
1146, Ill. 1040, Plate IV  
paralytic, 1086, 1087, 1088  
physiology of, 968, 974  
postoperative care following surgery of,  
1116, 1149  
complications of, 1149  
preoperative preparation for surgery of,  
1102  
pressure, measurement of, 81, 978  
prolapse, in female, 1064  
purpura of, 117  
quartz light irradiation of interior of, 1199,  
Ill. 1199  
radiotherapy of tumors of, 1057, 1110,  
1147, 1750 Ill. 1111, 1148, 1753,  
1754, 1757  
radium and x ray burns of, 993  
reimplantation of ureter into, 1303, 1316,  
1318, Ill. 1319  
rhabdomyoma of, 1047  
rupture of, 118, 179, 182, 918, 988, Ill.  
989  
operative treatment of, 1120  
sarcoma of, 1038, 1039, 1046, 1050, 1055,  
1057, 1093  
sphincter, 614, 793, 906, 945, 952, 968,  
971, 976, 979  
subarachnoid injection of alcohol for pain  
in, 1195  
sympathectomy for relief of pain in, 1134  
syphilis of, 117, 1023  
tabetic, 1135, Ill. 989, Plate III  
trichomonas vaginalis infestation of, 1036  
trigone of (see Trigonum vesicae)  
tuberculosis of (see Tuberculosis)  
tumors of (see Tumors)  
vaccine therapy of, 1195  
varices of, 117  
veins of, 956  
wall, resection of for diverticulum, 1111,  
Ill. 1113-1120  
Hunner's ulcer, 1113  
leukoplakia, 1117  
tumor, 1106, Ill. 1107-1111  
structure of, 948  
wounds of, 956  
operative treatment of, 988, 1120  
Blasucci ureteral catheter, 85  
Blood chemistry, relation of, to urinalysis, 52  
tests, 52  
importance of, in urology, 53  
securing specimens for, 61  
Blood plasma, dried human, 1766  
advantages of, over whole blood, 1767  
dangers of, 1768  
preparation and packaging of, 1766  
Blood supply of bladder, 955  
Cowper's gland, 735  
epididymis, 370  
kidney, 1345, 1349, 1356  
anomalies of, 1224, 1272, 1279, 1280  
1283, 1309, 1374, 1381, 1382,  
1409, Ill. 1280, 1410  
penis, 228  
prostate, 796  
scrotum, 366  
seminal vesicle, 525  
testicle, 370  
ureter, 1212  
urethra, female, 750  
vas deferens, 524  
Bone formation in penis, 295, 296  
Bougies, urethral, 71, 661  
technic of passing, 73  
Bowman's capsule, 1345, 1348, 1349, 1354,  
1355  
Brake prostatectomy bag, 891  
Bright's disease, 1423  
classification of, 1424  
degenerative changes of, 1424  
inflammatory changes of, 1424  
sclerotic lesions of, 1433  
treatment of, 1433  
uremia in, 1436  
treatment of, 1438  
Brown Buerger cystoscope, 104  
Bubo in chancroid, 262, 264, 266  
lymphogranuloma venereum, 282, 286  
Buck's fascia (see Fascia)  
Bulbocavernosus muscle, 227, 229, 241, 353,  
354, 527, 614, 969  
Bulbo-urethral gland (see Cowper's gland)  
Burns of urethra, 633  
radium and x ray, of bladder, 993  
Butterfield double-catheterizing children's  
cysto-urethroscope, 89, 122, 123,  
687, 1090, Ill. 89  
female urethroscope and infant vagino-  
scope, 90, 122, 594, 756, Ill. 91-94  
Calcification of vas deferens, ampulla, and  
seminal vesicle, 532, 552, Ill. 534  
kidney, tuberculous, 1497, 1509  
Calcified sebaceous cysts of scrotum, 432  
Calculus, cystine, 135, 1596  
of bladder, 117, 1067, 1092, 1157, Ill.  
1068, 1069, Plate VI  
diagnosis of, 129, 177, 1072  
in diverticulum, 129, 1072, Ill. 180,  
181, 1081  
removal of, by cystoscopic rongeur,  
1125, Ill. 1125  
litholaxy, 1072, 1126  
surgery, 1073, 1124



- kidney, 5, 168, 1583, III 1593, 1601  
   bilateral, 1584, 1609  
   diagnosis of, 127, 1603, III 149, 165  
   pyelography in, 168, 1605, III 165, 166, 167  
   due to sulfonamide therapy, 1171, 1594  
   etiology of, 1584  
   incidence of, 1597  
   location of, 1597  
   pathological renal changes in, 1599  
   recurrence of, preventing, 1606, 1609  
   structure and composition of, 1594  
   symptoms of, 1603  
   treatment of, 1606  
     by bisection of kidney, 1684  
     calyceal resection, 1606, 1684  
     heminephrectomy, 1606  
     nephrectomy, 1606  
     nephrotomy, 1606, 1674, III 1675-1677, 1678  
     pyelotomy, 1606, 1679, III 1680  
     transperitoneal, 1683, III 1681-1683  
 prepuce, 234, 309  
 prostate, 866, III 129, 867  
   symptoms and diagnosis of, 129, 869  
   treatment of, by operation, 870, 921, 932, 1760, III 934  
   radiation, 1760  
 scrotum, 431  
 seminal vesicle, 552, III 552  
 ureter, 168, 1259, 1294, III 1262, 1265, 1266  
   diagnosis of, 1262  
   by roentgenogram, 128, 168, 1264, III 165, 167  
   wax bulb catheter, 84, 1264, III 1263  
   in diverticulum, 1258, 1260, 1270  
   treatment of, 1266  
     expectant, 1268  
     instrumental, 1268  
     symptomatic, 1267  
     surgical, 1269, 1320, III 1321  
 urethra, female, 776, 777  
   treatment of, 777  
 urethra, male, 103, 129, 177, 665, 667, III 178  
   removal of, through perineal incision, 697, III 695, 696  
   suprapubic incision, 698, III 697, 698  
   urethroscope, 667, III 667  
 urinary, diet in treatment of, 1189, 1192, 1194, 1611  
   dissolution of, by chemical means, 1617  
   due to hyperparathyroidism, 60, 1070, 1270, 1591, 1616  
   etiology of, 1067, 1260, 1584  
   following alkali treatment of peptic ulcers, 1591, 1613  
   postoperative roentgenography in, 1610  
   preoperative roentgenography in, 1324  
   recurrence of, preventing, 1606, 1609  
   structure and composition of, 1260, 1594  
 Calyceal resection, 1606, 1684  
   technic of, 1685  
 Capsule, Bowman's, 1345, 1348, 1349, 1354, 1355  
   Gerota's, 1351, 1480  
   prostatic, 792, 793  
   renal, 1349, 1351, 1353  
 Carbuncle of kidney, 1453, 1456, III 1455  
   treatment of, 1460, 1481  
 Carcinoma of adrenal cortex, 1576  
   bladder, 1039, 1041, 1049, 1050, III 1042-1045, 1054, Plate IV  
   diagnosis of, 1053  
   in diverticulum, 1049, 1059, III 1112-1114  
   exstrophy, 964, 1050  
   treatment of, by excision, electro-resection, or fulguration, 1057, 1106, 1147, 1324, 1751, III 1107-1111, 1148, 1149, 1757  
   radiation, 1057, 1110, 1147, 1750, III 1111, 1148, 1753, 1754, 1757  
 Cowper's gland, 742  
   treatment of, by operation, 743, 1743  
   radiation, 743, 1743  
 kidney parenchyma 1542, 1562  
   diagnosis of, 1571  
   pathogenesis of, 1562  
   pathology of, 1563, 1564, 1565  
   treatment of, by operation, 1573, 1760  
   radiation, 1573, 1760  
 pelvis, 1529, 1545, III 1546, 1547  
   diagnosis of, 1550  
   treatment of, by operation, 1552, 1758, III 1325-1328  
 penis, 300, 306, III 301-304  
   differential diagnosis of, 279, 283, 299  
   treatment of, by fulguration, 333, 1735  
   operation, 323, III 324-331  
   radiation, 303, 1734  
 prostate gland, 831, 844, 1747  
   biopsy of, 851, III 852-855  
   diagnosis of, 850  
   etiology of, 844  
   metastases from, 845  
   pathology of, 845, 1747, III 847, 848, 849  
   prognosis of, 856  
   relation of serum acid phosphatase to, 853  
   treatment of, 498, 857, 918  
     by castration, 498, 858  
     estrogenic substances, 859  
     radiation, 858, 1747, III 1748  
     supervoltage irradiation of testes, 859  
     surgery, 857, 918, 920, 1747  
     transurethral resection, 852, 910, 1747, III 1748

- Carcinoma, scrotum**, 429  
   treatment of, by radiation, 431, 1736  
   surgery, 431, 1736  
**seminal vesicle**, 550  
   treatment of, by radiation, 55, 1739  
   surgery, 551, 1739  
**spermatic cord**, 464, 1739  
**testicle**, 454, 461  
   treatment of, by radiation, 387, 462, 1737  
   surgery, 461, 498, 1737, III 500, 501  
**ureter**, 1252  
   treatment of, by radiation, 1758  
   surgery, 1257, 1324, III 1325-1328  
**urethra, female**, 103, 769  
   treatment of, by radiation, 770, 1744  
   surgery, 770, 1744  
   male, 650, III 652, 653, 654, 655  
   treatment of, by radiation, 656, 657, 1742  
   surgery, 656, 657, 1743  
**vagina**, 599  
   treatment of, by radiation, 599, 600, 1739  
   surgery, 599, 600, 1740  
**vulva**, 590  
   treatment of, by radiation, 591, 1739  
   surgery, 591, 1740  
**Caruncle of female urethra**, 103, 767, 769  
   treatment of, 768  
**Carunculae hymenales**, 576, 598  
**Castration, effects of**, 391  
   for prostatic carcinoma, 498, 858  
**Catheterization of ejaculatory duct**, 97, 101, 185, 477, 547  
   technic of, 97, 563, III 97, 98  
**ureter**, 83, 1715  
   in children, 122, 123  
   preparation for, 87  
   technic of, 118  
**urethra**, 74  
   preparation for, 77  
   technic of, 78  
**Catheters, ureteral**, 84  
   care of, 86  
   indwelling, 1315, 1471, 1473, 1716  
   types and sizes of, 84  
   wax bulb, 84, 1264, III 1263  
**urethral**, 74  
   care of, 77  
   self retaining, 75  
   types and sizes of, 74  
**Cavernositis, gonorrheal**, 710, 712  
   indurated, 293  
   tuberculous, 288  
**Chancere (see Syphilis)**  
**Chancroid of penis**, 261  
   differential diagnosis of, 261, 263, 278, 283  
   etiology and bacteriology of, 261  
   treatment of, 264  
**scrotum**, 417  
**vagina**, 597  
**vulva**, 586  
**Chemical nephrosis**, 1432  
**decapsulation in**, 1436  
**tests of urine**, 30  
**Children, anesthesia for**, 100, 122, 197, 217, 318, 319  
   bladder tumors in, 1092  
   cystoscopy and urethroscopy in, 122  
   diseases of bladder in, 1092  
   Cowper's gland, 743  
   kidney, 1461, 1463, 1465, 1629  
   prostate, 870  
   scrotal contents, 477  
   seminal vesicle, vas deferens, and ejaculatory duct, 553  
   ureter, 1293  
   urethra, female, 777  
   male, 667  
   vulva, 591  
   gonorrheal vulvovaginitis in, 591, III 593  
   hydronephrosis in, 1408, 1630  
   pyelitis in, 1461, 1463, 1465, 1630  
   renal tuberculosis in, 1492, 1501  
   tumors of kidney in, 1444, 1553, 1759  
**Chordee of penis**, 335, 340, 344, III 337, 338, 344  
**Chorionepithelioma of testicle**, 454, 455, 459, Frontispiece  
   vagina, 600, 1740  
**Chyluria**, 28, III 155  
**Circumcision**, 234, 253, 256, 297, 310  
   anesthesia for, 319  
   cautery, in adults, 322  
   in female, 602  
   technic of, 319  
     Kirwin's, 319, III 321  
     Lowley's, 319, III 320  
**Clinical tests of urine**, 24  
**Clitoridectomy**, 602  
**Clitoris**, 571  
   adherent, 577  
   anomalies, congenital, of, 577  
   excision of, 602  
   glans of, 572  
**Coffey's technics of uretero-intestinal anastomosis**, 1326, 1329  
**Collection of urinary specimens**, 21, 118  
**Concealed penis**, 230  
**Condyloma acuminata of female external genitalia**, 587, 597  
   penis, 296  
   lata in female, 585, 597  
   penis, 297  
   scrotum, 417, 418  
**Constriction of penis**, 251, III 252  
**Contracture of vesical orifice**, 842, 1065, III 1066  
**Contusion of kidney**, 1396, 1403  
   penis, 247  
   scrotum, 400  
   testicle and epididymis, 405, 407  
**Cord bladder**, 1086  
   treatment of, 1088, 1135, 1160  
**Corona glandis**, 226  
**Coronary sulcus**, 224, 225, 226, 227, 607, 608

- Corper's crystal violet potato method of detecting tubercle bacilli in urine*, 42
- Corpora cavernosa penis*, 224, 226, 228, 229, 309, 609
- Corpus spongiosum urethrae*, 224, 226, 609, 612
- Cowperitis*, 737  
abscess-formation in, 738  
fistula following, 738  
operative treatment of, 743
- Cowper's gland*, 612, 732  
abscess of, 713, 738, 739  
anatomy of, 734  
anesthesia for surgery of, 218, 743  
anomalies, congenital, of, 736  
blood supply of, 735  
carcinoma of, 742, 743, 1743  
diseases of, 737, 743  
ducts of, 613, 735  
embryology of, 732  
extirpation of, 745  
gonorrheal infection of, 737, 738  
incision and drainage of, 745, Ill 744, 745  
injuries of, 736  
innervation of, 736  
lymphatics of, 736  
non specific infections of, 737  
number and classification of, 733  
operative treatment of, 743  
physiology of, 736  
postoperative care of, 746  
retention cysts of, 740, 743  
secretion of, 736  
structure of, 734  
tuberculosis of, 739  
tumors of, 742, 1743  
veins of, 736
- Creatinine*, test of blood for, 60, 61
- Crista urethralis*, 749
- "Crush" injuries, disturbances of kidney function following, 1444
- Cryoscopy*, 66
- Cryptorchidism*, 364, 369, 371, 385, 387, 476, 477  
complications of, 378, 453, 467, 468, 487  
hormonal treatment of, 379, 478  
operative treatment of, 379, 487, Ill 489, 490, 493  
types of, 376, Ill 377
- Curtis' method of ureteral anastomosis*, 1318
- Cutaneous affections of scrotum and penis*, 256, 414  
vulva, 581
- Cylindrical syphiloma of male urethra*, 638
- Cystadenoma, malignant papillary, of kidney*, 1565
- Cystectomy*, 641, 865, 1059, 1117, 1123  
technic of, 1119
- Cystine*, 29, 40  
calculus, 135, 1596
- Cystinuria*, 40
- Cystitis*, 994, 1092, Ill 1000, Plate II  
acute, 116, 998, 1004, 1005  
alkaline encrusted, 999, 1011, 1050, Plate II  
amebic, 1036  
bacterial, 995  
chronic, 32, 116, 999, 1006  
cystica, 1001, 1050  
diagnosis of, 1003  
diet in treatment of, 1006, 1007, 1008  
emphysematosa, 1001  
etiology of, 995  
factors predisposing to, 997  
follicularis, 1001  
gangrenous, 999, 1008  
glandularis, 1001  
gonorrheal, 761, 1022, Ill 1022, 1023  
granulomatosa, 999  
interstitial 998, 999, 1014, Plate II  
non bacterial, 995  
panmural ulcerative, 1014  
postoperative, 995  
postpartum, 996  
pregnancy, 996  
pseudomembranous, 1002  
symptoms of, 1002  
treatment of, 1005  
tuberculous, 1026  
types of, 998  
ulcerative, 116 1002, 1014
- Cystocele*, 183, 757, 1064  
treatment of, 1065
- Cystography, injection*, 172, Ill 180, 181  
contrast media for, 172  
in female, 183  
technic of, 173  
uses of, 176, 1055
- Cystometer*, 82, 978  
Lowsley Hunt, 82, Ill 82
- Cystometry*, 81  
uses of, 978
- Cystoscopes*, care of, 111  
types of, 104
- Cystoscopy*, 104  
anesthesia for, 113  
care of patient after, 122  
in children, 122  
indications and contraindications for, 108  
instruments for, 104  
care of, 111  
preparation of armamentarium for, 111  
of patient for, 113  
technic of, with examination of upper tract, 114
- Cystostomy (see Suprapubic)*
- Cysto urethrography*, technic of, 175  
uses of, 176, 819
- Cysts, dermoid of spermatic cord*, 464  
vagina, 598  
vulva, 589  
hydatid (see *Echinococcus*)  
of Bartholin's gland, 589  
Cowper's gland, 740, 743  
treatment of, 741  
hy men, 600

- Cysts, kidney, 159, 1403, 1530, 1633  
 echinococcus (see Echinococcus)  
 hemorrhagic, 1538, 1540, 1542, 1545  
 simple serous, 1538, III 161, 1539  
 multilocular, 1544  
 unilocular, 1538  
   calcified, 1541  
   contents of, 1542  
   diagnosis of, 1543  
   etiology of, 1538  
   treatment of, by aspiration and injection, 1544, 1688  
     operation, 1544, 1688  
 small, multiple retention, 1530, 1538  
 solitary (see Simple cyst)  
 penoscrotoperineal raphe, congenital, 240  
 prostate, 824, 826  
 prostatic utricle, congenital, 625, 825, III 625  
 urachus, 966, 967  
 urethra, male, 645, 648  
 vagina, 598  
 vulva, 589  
 sebaceous, of scrotum, 428, III 428  
   calcified, 432  
   vulva, 589
- Dark field examination for syphilis, 268, 298
- Dartos, 227, 365, 366, 367
- Decapsulation of kidney, 1435, 1707  
 technic of, 1708
- Decompression, gradual, of bladder, 883, 1159
- Deferentitis, gonorrheal, 529  
 non specific, 530
- Delzell ejaculatory-duct catheter, 185, 563
- Deming's method of nephropexy, 1707
- Denervation of kidney, 1711
- Denonvilliers' fascia (see Fascia)
- Denudation of penis, 250
- Dermoid cysts of spermatic cord, 461  
 vagina, 598  
 vulva, 589
- Diaceturia, test for, 32
- Diet, acid ash, 1007, 1008, 1189, 1612  
 alkaline ash, 1006, 1192, 1314, 1614  
   Brady modified, 1193  
   as etiological factor in urinary calculous, 1584  
   Brady restricted, 938, 1198  
   in treatment of cystitis, 1006, 1007, 1008  
   nephritis and nephrosis, 1434  
   prostatic conditions, 816, 885, 908, 938  
   urinary stone, 1189, 1192, 1194, 1611  
   urinary tuberculosis, 1193, 1198  
   ketogenic, 1008, 1187, 1473  
   low oxalate, 1194, 1613  
   low calcium modification of, 1195
- Dilatation, instrumental, of ejaculatory duct 563  
 ureter, 1197, 1276, 1717
- urethra, in female, 759, 764, 772, 786  
 male, 661, 673, 676, 685, 699, 722, 746, 816  
 of ureter, congenital (see Megalo-ureter)  
 due to obstruction (see Hydro-ureter)
- Diphtheria of penis, 288
- Diseases of bladder, 994, 1092  
 Cowper's gland, 737, 743  
 ejaculatory duct, 553  
 epididymis, 433, 477  
 female external genitalia, 581  
 hymen, 576, 600  
 kidney and renal pelvis, 1405, 1629  
 penis, 252  
 prostate gland, 806, 870  
 scrotum, 414  
 seminal vesicle, 535, 551  
 testicle, 433, 477  
 ureter, 1239, 1293  
 urethra, female, 757, 777  
   male, 637, 667  
 vagina, 594  
 vas deferens, 529, 553  
 vulva 581, 591
- Dislocation of penis, 251
- Diverticulum of bladder, 117, 177, 958, 1080, Plate VII  
 cystography in 177, 1084, III 181  
 diagnosis of, 1083  
 etiology of, 1081  
 operative treatment of, 1084, 1111, III 1113 1115, 1116-1120  
   stone in, 129, 1072, III 180, 181, 1081  
   tumor in, 1049 1059, III 1112-1114  
 ureter, 170, 1220, 1224, 1257, 1294, III 1258  
   calculus in, 1258 1260, 1270  
   treatment of, 1259  
 urethra, female, 751, 758, 774, 776  
   treatment of, 759, 776, 777  
   urethrography in, 179  
 urethra, male, 102, 179, 623, 663, 665, III 182, 664  
   operative treatment of, 626, 665, 667, 691, III 688
- Dorsal slit, 234, 253, 261, 266, III 254
- Duplication of bladder, 958  
 kidney, 145, 150, 1221, 1224  
   operative treatment of, 1670, 1693  
 penis, 231, III 233  
 ureter, 150, 1214, 1215, 1221, 1223, III 146, 149, 1216-1218  
   operative treatment of, 1225, 1302  
 urethra, female, 751  
   male, 626  
 vagina, 577
- Dye tests of renal function, 46, 121, 1388
- Echinococcus disease of bladder, 1035  
 kidney, 37, 1520, 1631  
   diagnosis of, 1523  
   operative treatment of, 1524  
 ureter, 1250

- Ectopic kidney, 151, 1380  
 anomalous blood supply of, 1381  
 operative treatment of, 1683, 1694  
 stone in, 1683, Ill 167  
   transperitoneal pyelotomy for, 1683,  
   Ill 1681-1683  
 with crossed ureter, 150, 1219, 1380,  
   Ill 147  
   and fusion 1378, Ill 1379  
*testicle*, 364, 376, 477, Ill 494  
 complications of, 378 487  
 operative treatment of, 379, 487, 493,  
   Ill 495, 496 497, 499  
 ureteral orifices 629, 750, 1220, 1223,  
   1225, Ill 1216, 1218  
 operative treatment of, 1226, 1303
- Ejaculation*, 527, 629
- Ejaculatory duct 521, 529, 536, 557, 611, 798  
 anatomy of, 523, 524, 525  
 anomalies, congenital of, 526  
 catheterization of 97, 101, 185, 477, 547,  
   563, Ill 97, 98  
 dilatation of, 563  
 diseases of, 553  
 embryology of, 361, 522, 609  
 injection of 563  
 injuries of, 529  
 non-operative treatment of, 562  
 physiology of, 526  
 stricture or occlusion of, 477, 553, 565
- Elephantiasis of penis 283, 292, 426, Ill 292  
 scrotum, 292, 417, 424, Ill 292  
 etiology of, 424  
 treatment of, 426  
 vulva, 587
- Ellbott treatment regulator for applying  
 heat to prostate, 937
- Elsner Braasch endoscope, 88
- Embryology of bladder, 943  
 Cowper's gland, 732  
 ejaculatory duct, 361, 522, 609  
 epididymis, 361  
 female external genitalia, 361, 569  
 kidney, 1343  
   pelvis 1208, 1346  
 penis, 223  
 prepuce, 225  
 prostate, 787, Ill 788, 789  
 scrotum, 360  
 seminal vesicle, 361, 521  
 spermatic cord, 363, 364  
 testicle, 361  
 trigonum vesicae, 944, 946  
 ureter, 1208, 1346  
 urethra, female 569, 748  
   male 225, 607  
 vas deferens 361, 521  
 verumontanum, 522, 609  
 vagina, 570
- Embryonal adenomyosarcoma of kidney (see  
*Wilms' tumor*)
- Emmet's "buttonhole" operation for pro-  
 lapse of urethra, 783
- Encysted hydrocele, 376, 467
- Endoscopes, 87
- Entamebae histolytica infection of bladder,  
 1036
- Enuresis, 623, 629, 1088  
 causes of, 1089  
 treatment of, 1091
- Epididymectomy, 445, 465  
 technic of, with transplantation of vas to  
   skin of groin, 445, 502, 510, Ill  
   503-505  
 transplantation of vas to testicle following,  
   504, Ill 506
- Epididymis, anatomy of, 370  
 anesthesia for surgery of 218, 486  
 angoma of 465  
 anomalies, congenital, of, 384  
 arteries of, 370  
 blood supply of, 370  
 contusion of, 406 407  
 diseases of, 433 477  
 embryology of 361  
 gonorrheal infection of, 409, 436, 475,  
   517, 712  
 gumma of, 447  
 inflammations of (see *Epididymitis*)  
 injuries of, 405  
 innervation of, 371  
 lymphatics of, 373  
 neuralgia of testicle and, 449  
 non operative treatment of 517  
 non specific infections of, 438, 475, 517  
 operative treatment of, 486  
 palpation of, 19  
 postoperative care following surgery of,  
   510, 512, 516  
 preoperative preparation for surgery of,  
   486  
 sarcoma of, 465  
 syphilis of (see *Syphilis*)  
 tuberculosis of (see *Tuberculosis*)  
 tumors of (see *Tumors*)  
 veins of, 371  
 wounds of, 405, 407
- Epididymitis, gonorrheal, 409, 436, 475, 712,  
 713  
 treatment of 438, 517  
 non specific, 438, 475  
 treatment of, 440, 517
- Epididymotomy, 438, 501  
 closed, technic of, 501  
 open, technic of, 502
- Epididymo-vasotomy for sterility, 477, 505  
 Hagner's technic of, 508, Ill 507, 509  
 indications for, 508
- Epispadias in female, 579  
 treatment of, 580, 603, Ill 604, 605  
 types of, 579, Ill 238  
 male, 237  
   complete, 239  
   glandular, 239  
   operation for, 348, Ill 348  
   operations for, 347

- Epispadias, male, penile, Young's operation for, 349, Ill 349  
 surgical treatment of incontinence accompanying, 239, 350  
 types of, 239, Ill 238
- Epididymitis of scrotum, 429  
 treatment of, by operation, 431, 1736  
 radiation, 431, 1736  
 urethra, male, 650, Ill 652, 653, 654, 655  
 treatment of, by operation, 656, 1743  
 radiation 656, 1742
- Erection of penis, mechanism of, 241  
 muscles and nerves involved in, 228, 241, 527  
 pathological (see Priapism)
- Erosive and gangrenous balanitis, 259, 264  
 treatment of, 261
- Erythrocyte sedimentation test, 67
- Examination, dark field, for syphilis, 268, 298  
 instrumental, 71  
 in children, 122  
 with cystoscope, 104  
 ureteral catheters, 83  
 urethral bougies, sounds, filiforms, 71  
 catheters, 74  
 urethroscope or endoscope, 87  
 of blood, 52, 62, 67  
 prostatic secretion, 18, 541, 716, 814  
 semen in sterility, 476  
 seminal vesicular secretion, 18, 541, 565, 716, 814  
 urine (see Urine)  
 physical, in urology 11, 12  
 rectal, 15, 54, 813, 819, 824, 850
- Excretory urography, 138  
 as measure of residual urine, 171  
 for examination of bladder and urethra, 176, 624  
 in injuries to bladder, 179, 992  
 kidney, 1402  
 male urethra, 183  
 postoperative studies following uretero-intestinal anastomosis, 1337  
 intravenous method of, 138  
 peroral method of, 142  
 preparation of patient for, 141  
 subcutaneous method of, 141
- Exstrophy of bladder, 960, 1092, Ill 961  
 carcinoma in 964, 1050  
 etiology of, 962  
 operative treatment of, 1122  
 by uretero-intestinal anastomosis, 1123, 1324  
 with epispadias in female, 579, 963  
 male, 237, 963
- External genitalia, female, anatomy of, 571  
 anesthesia for surgery of, 602  
 anomalies, congenital, of, 381, 576  
 condyloma acuminata of, 587, 597  
 diseases of, 581  
 embryology of, 361, 569  
 injuries to, 581  
 operative treatment of, 602  
 postoperative care following surgery of, 605  
 preoperative preparation for surgery of, 602  
 radiation of tumors of, 1739
- External urethrotomy (see Urethrotomy)
- Extrapentoneal lumbar nephrectomy, 1658, 1660, Ill 1660-1663
- Extravasation of urine in injuries to bladder, 987  
 prostate, 805  
 ureter, 1315  
 urethra, 635  
 operative treatment of, 637, 679, 684, Ill 680, 681
- Fascia, Buck's, 226, 293, 294, 295, 358, 635  
 cremasteric, 366, 412  
 Denonvilliers', 562, 795, 893, 922  
 external spermatic, 366  
 internal spermatic, 366  
 penile, 1351, 1481, 1620  
 prostatic, 795
- Fehling test for sugar in urine, 31
- Fenger operation for stricture at the ureteropelvic junction, 1307, Ill 1307 1308
- Fetal kidney, 1372
- Fibroma of bladder, 1047  
 kidney, 1568  
 penis, 295  
 renal pelvis, 1546  
 spermatic cord, 463  
 testicular tumors, 465  
 urethra, female, 769  
 male, 649  
 vagina 599  
 vulva, 589
- Fibrosis, chronic, of prostate, 921
- Filiforms urethral, 71, 74, 661
- Fistula of urachus, 965, 967  
 ureter, 1234, 1235, 1237, 1269  
 urethra male, 647, Ill 647  
 recto-urethral, repair of, 695, Ill 691-693  
 urethropenile 738 740  
 excision of, 691 Ill 689, 690  
 urethrovaginal 756  
 repair of, 784 Ill 784, 785  
 vesical 118 994, 1076, Plate VII  
 vesico-enteric, 1077  
 vesico-uterine, 1079  
 vesicovaginal, 581, 756, 994, 1076  
 operative treatment of, 1128, 1324, Ill 1130-1134
- Fluids, forcing of, 885, 905, 1154 1611, 1717  
 method of charting intake and output of, 1154
- Foley self retaining catheter, 76, 884, 897, 905 916, 917, 928, 929
- Y plasty operation for stricture at ureteropelvic junction, 1309  
 technic of 1313
- Follicular abscess 12, 644, 710  
 urethritis in male, 710  
 vulvitis, 583

- Foreign body in bladder, 117, 1073  
 removal of, 1075, 1124, Ill 1074  
 urethra, male, 632
- Foreskin (see Prepuce)
- Fossa navicularis in female, 571, 576  
 male, 225, 612, 613, 617, 638, 652, 708
- Fracture of penis, 249, 250
- Frei test for lymphogranuloma venereum,  
 283, 597
- Frenum preputi, 225, 227
- Fulguration of cervical and vaginal glands in  
 vulvovaginitis, 594  
 infected urethral glands in male, 646  
 female, 764  
 prolapsed urethra in female, 783  
 tumors of bladder, 1057, 1146, 1152  
 penis, 333  
 urethra, male, 649  
 urethral polyps and granulomas in female,  
 759  
 ulcers of bladder, 1018, 1197
- Fuller Frey technique of suprapubic prosta-  
 tectomy, 887, Ill 888, 889, 890,  
 892
- Function tests of kidney (see Tests)
- Furunculosis of vulva, 583
- Fused kidney, 150, 1373  
 asymmetrical, 150, 1375, Ill 147, 1376  
 horseshoe form of, 150, 1373, Ill 146, 147,  
 1373, 1374, 1375  
 containing hypernephroma, papilloma,  
 stone, 1691, Ill 1691-1692  
 heminephrectomy in, 1670, 1690, 1691,  
 Ill 1691  
 operative treatment of, 1378, 1689  
 retrograde pyelography in, 150, Ill 146,  
 1375  
 unilateral, with crossed ectopy, 1378, Ill  
 1379
- Galatest for sugar in urine, 31
- Ganglioneuroma of adrenal gland, 1580
- Gangrene of bladder, 999, 1008, 1010  
 penis, 254, 259, 419, Ill 258  
 scrotum, 404, 405, 419  
 and penis following peniurethritis,  
 419, 422, Ill 420  
 vagina, 595  
 vulva, 584  
 spontaneous fulminating, of scrotum and  
 penis, 419  
 treatment of, 422
- Garceau ureteral catheter, 84
- Gas bacillus infection of kidney, 1517  
 treatment of, 1520
- Gerota's capsule, 1351, 1480
- Glans penis, 225, 227, 228, 608  
 dorsal slit of, 234, 253, 261, 266, Ill 254  
 Paget's disease of, 290, 301  
 clitoridis, 572
- Glass tests of urine, 24
- Glomerulonephritis (see Nephritis)
- Gonorrhea, bacteriology of, 705  
 complement fixation test for, 707, 716,  
 727, 765  
 history of, 702  
 immunology of, 707  
 in female, 755, 759  
 complications of, 436, 760, 761  
 criteria of cure of, 765  
 diagnosis of, 761  
 pathology of, 760, Ill 1023  
 treatment of, by chemotherapy, 763,  
 764  
 local, 763, 764  
 prophylactic, 762  
 in male, 701  
 complications of, 644, 710, 711  
 criteria of cure of, 726  
 diagnosis of, 715  
 pathology of, 708, 711  
 peniurethral and paraurethral abscess  
 in, 710, 711  
 symptoms of, 712  
 treatment of, 717  
 local, 721  
 prophylactic, 718  
 systemic, 725  
 with hyperpyrexia, 726, 817  
 penicillin, 720, 1185  
 sulfonamides, 717, 719, 722, 724,  
 727, 1165, 1166, 1167  
 modes of transmission of, 708  
 public health and epidemiological aspects  
 of, 703  
 urine examination in, 39, 716
- Gonorrheal cavernositis, 710, 712
- Infection of bladder, 761, 1022, Ill 1022,  
 1023  
 Cowper's gland, 737, 738  
 ejaculatory duct, 553  
 epididymis, 375, 409, 436, 712, 713  
 differential diagnosis of, 437  
 treatment of, 438, 517  
 kidney, 1512  
 prostate, 710, 712, 713, 724, 806, 810,  
 818  
 seminal vesicle, 535, 546, 710, 712, 713,  
 714  
 ureter, 1246  
 urethra (see Gonorrhea, in female, in  
 male)  
 vagina, 591, 592, 594, Ill 593  
 vas deferens, 529  
 vulva, 585, 591  
 vulvovaginitis in children, 591  
 treatment of, 592, Ill 593
- Granuloma inguinale in female, 586  
 male, 278, 419  
 differential diagnosis of, 279, 283  
 treatment of, 280
- Granuloma of urethra in female, 758, 759,  
 768  
 ureter, 1244
- Gubernaculum testis, 363 411, 412

- Guinea pig inoculation test for urinary tuberculosis, 42, 1028, 1503, 1504
- Gumma, syphilitic, of bladder, 1023, 1025, 1026
- epididymis, 447
- kidney, 1514, III 1513
- penis, 295
- prostate, 820
- scrotum, 418
- testicle, 446, 459, III 447
- ureter, 1247
- urethra, female, 766
- male, 639
- vulva, 586, 766
- Hagner's technic of epididymo-vasotomy, 507, 508, III 507, 509
- Hemangioma of bladder, 1048, 1093
- kidney, 1569
- Hematocele, 401, 458, 469, 470
- treatment of, 404
- Hematoma, extrarenal, 163, III 163
- of penis, 247, III 248
- scrotum, 401, 473, 513, III 248
- calcified, 431
- treatment of, 404
- Hematoporphyrinuria, 10
- Hematuria, 7, 29, 35, 108
- causes of, 7
- Heminephrectomy, 1670
- in anatomically normal kidney, 1671, III 1672
- double kidney, 1670, 1693
- horseshoe kidney, 1670, 1690, 1691, III 1691
- indications for, 1303, 1304, 1670
- Hemoglobinuria, 10, 35
- anuria, 7
- Hemorrhagic cyst of kidney (see Cysts)
- Hermaphroditism and pseudohermaphroditism, 381, 390
- Hernia, inguinal, accompanying cryptorchidism, 378
- congenital, 364
- differentiation of, from hydrocele, 470
- Herniation of bladder, 1061
- treatment of, 1063
- testicle, 400, 401, 408
- Herpes progenitalis of penis, 287
- Hess method of orchidectomy, 498
- Higgins' technic of uretero-intestinal anastomosis, 1330
- Hilus of kidney, 1352, 1360
- History taking in the urological case, 1
- Hodgkin's disease of penis, 283, 304
- testis, 462
- Home's glands, 792, 800, 949
- Hormonal test for early pregnancy, 43
- tumor of testis, 44, 451, 453, 459
- therapy of cryptorchidism, 379, 478
- carcinoma of prostate, 858, 859
- Hunner's ulcer in female, 1019
- hyperplasia of prostate, 393, 840, 908
- impotence, 394
- vulvovaginitis in children, 592
- Hormones of testis, 386, 388
- influence of, on testicular descent, 364, 379
- therapeutic use of, 379, 392, 478, 908
- Horseshoe kidney (see Fused kidney)
- Hour glass bladder, 959
- Hunner's ulcer of bladder (see Localized submucous fibrosis)
- Hutchins' method of uretero-intestinal anastomosis, 1334
- Hydatid cyst (see Echinococcus)
- of Morgagni, 361, 375
- torsion of, 414
- Hydrocalyx, 1422
- Hydrocele, 466, 473
- congenital, 466, 470
- diagnosis of, 469
- etiology of, 466
- fluid content of, 468
- idiopathic, 466
- in female, 582
- infantile, 466, 470
- inguinal, 379, 467
- interstitial, 468
- of hernial sac, 468, 470
- spermatic cord, 468, 470
- tunica vaginalis testis, 413, 458, 467, 478, III 467
- traumatic rupture of tunica vaginalis in, 404
- treatment of, 471, 510
- by aspiration and injection, 471, 511
- operation 471, 512
- tapping, 471, 510
- Hydrocelectomy, 512
- Hydrogen ion concentration of urine (see pH)
- Hydronephrosis, 1405, 1630, III 1217, 1280
- 1307, 1410, 1415
- causes of, 1406
- diagnosis of, 1418
- infected, 1405, 1462
- intermittent, 1405
- pathology of, 1414
- pyelography in, 151, 1419, III 153
- renal atrophy in, 1416
- serial pyelograms in, 136, 1420
- treatment of, 1420
- Hydro-ureter, 1283, 1294, III 618, 1217
- etiology of, 1284
- Hymen, atresia of, 578, 600
- cysts of, 600
- development of, 571
- imperforate 578
- tumors of, 600
- Hypernephroma of kidney, 1562, 1563, 1564
- bilateral primary, 1569
- diagnosis of, 1571
- treatment of by radiation, 1573, 1760
- surgery, 1573, 1760



- Hyperparathyroidism in the production of urinary stone, 60, 1070, 1270, 1591, 1616
- Hyperplasia of adrenal cortex, 1576
- prostate gland, 110, 826
- blood chemistry tests in, 53
- complications of, 835
- cystoscopic appearance of, 116, 836, III 836, 837, Plate V
- cysto-urethrogram in, 177, III 178
- etiology of, 826, III 828, 829
- pathology of, 831, III 838, 839, 882, 883, 903, 904
- symptoms and diagnosis of, 834, 835
- treatment of, by castration, 498, 858
- hormonal therapy, 393, 840, 908
- perineal prostatectomy, 858, 881, 891, III 893-901
- roentgen radiation, 1745
- suprapubic prostatectomy, 881, 887, III 888-892
- total perineal prostatectomy, 920, 922, III 923-928
- transurethral resection, 909
- Hyperpyrexia therapy of gonorrhea, 717, 817
- syphilis*, 276
- Hypertension, arterial, current theories of mechanism of, 1441
- renal pressor substances and, 1439
- treatment of, 1442
- by surgery, 1710
- clinical results of, 1712
- urological conditions associated with, 1443, 1558
- Hypertonic bladder, 980, 1087, 1160
- Hypertrophy of kidney, 1369, III 1368
- prostate gland (see Hyperplasia)
- trigonum vesicae*, 1065, Plate V
- excision of, 1067, 1145, III 1145
- vesical orifice, congenital, 964
- Hypoplastic kidney, 1367, III 146, 1368, 1369, 1370, 1371
- treatment of, 1370
- Hypospadias in female, 578
- treatment of, 579, 603
- male, 234, 629
- chordee associated with, 335, 340, 341, III 337
- surgical correction of, 340, III 338, 344
- etiology of, 235
- glandular, 236
- operation for, 340, III 339
- penile, 236
- operation for, 340, III 340
- penoscrotal, 236
- Lowsley three-stage operation for, 340, III 341-347
- operations for, 335
- types of, 236, III 235
- Hypotonic bladder, 980
- Imperforate anus, urethra, vagina, case of, 576, III 573-575
- hymen, 578
- urethra, male, 616
- Impotence, 310, 475, 561, 922
- Lowsley plication operation for, 312, 350, III 351-357
- treatment of, 311, 350, 394
- Incised wound of penis, 245, III 246
- Incontinence of urine, 617, 623, 629, 756, 757, 805, 1088, 1223
- and feces in male, Lowsley Hunt plication operation for, 1137, III 1140, 1141
- causes of, 1091
- in epispadias in female, 579
- operative treatment of, 603, III 604, 605
- male, 239, 350
- operative treatment of, 350
- hypospadias in female, 603
- spina bifida, 1091, 1092
- Kelly plication operation for, 1142
- Lowsley plication operation for, 1140, III 1142, 1143
- Lowsley repair of vesical orifice for, 1137, III 1138, 1139
- muscle transplantation operations for, 1144
- postprostatectomy plication of external sphincter to prevent, 897, III 902
- surgery for, in male and female, 1137
- Indigo-carbune test of renal function, 49, 121, 1388
- Inguinal lymph nodes, 229
- extirpation of, in cancer of penis, 323, III 324-331
- carcinoma of urethra, female, 770, 1744
- epithelioma of scrotum, 431
- involvement of, in cancer of penis, 302, 303, 323, 334, 1735 III 304
- cancer of urethra, male, 653, 656, 1743, III 652
- chancroid, 262, 263, 264, 266
- lymphogranuloma venereum, 282, 283, 286
- lymphogranulomatosis of penis, 305
- pungo of scrotum*, 415
- syphilis* in female, 585
- Inguinolabial abscess, 585
- Injuries of bladder, 118, 179, 918, 986
- Cowper's gland, 736
- ejaculatory duct, 529
- female external genitalia, 581
- kidney, 170, 1395, III 169, 1397
- diagnosis of, 1401
- operative treatment of, 1695, 1699, III 1696-1698
- penis, 245, 308
- repair of, 334
- prostate gland, 805
- renal pelvis, 1403
- scrotum, 400

- Injuries seminal vesicle 529  
 testicle and epididymis 405  
 ureter 140 1232 1412  
   diagnosis of 1236  
   treatment of 1236 1315 1317  
 urethra, female 755 756  
   male 632  
     operative treatment of 69 II 680-683  
 vas deferens 408 529  
 vulva 581
- Innervation of bladder 951 952 955 969 1134  
 Cowper's gland 736  
 epididymis 371  
 kidney 1359 1708  
 micturition 969  
 penis 228 241 356  
 prostate 193 98  
 scrotum 367  
 seminal vesicle 525  
 testicle 371  
 ureter 1212  
 urethra female 750 969  
   male 969  
 vas deferens 372 3 3 524
- Intermittent bladder irrigation 1159  
 Internal urethrotomy (see Urethrotomy)  
 Interstitial cystitis 998 999 1014 Plate II  
 Intertingo of vulva, 583  
 Intravenous pyelography (see Excretory urography)  
 Inulin test of renal function, 1387  
 Irrigations of bladder 885 937 100 1158 1197  
   intermittent, 1159  
   solutions used in 1158  
   renal pelvis 1473 1611 1715  
   solutions used in 1611 1716  
 Ischioavernosus muscle 277 229 241 353 354 525
- Jewett's method of uretero-intestinal anastomosis 1331
- Kaposi's disease of penis 299  
 Kelly endoscopic tube 87  
   plication operation for urinary incontinence in female 1142  
 Ketogenic diet (see Diet)  
 Kidney 1343 1395 1655  
   abscess of 1153 1460 1481 III 1495 1497 1526  
     operative treatment of 1686  
   absence congenital of 1362  
   actinomycosis of 1525 1631 III 1526  
     treatment of 1529  
   adenocarcinoma of 1564 1 60 III 1564  
   adenoma of 1566  
   amyloid degeneration of 29 1437  
   anatomy of 1350  
   anesthesia for surgery of 219 1655  
   anomalies, congenital of 145 1361 1408 III 147 149  
     operative treatment of 1689  
   aplasia of 1371  
   arteries of 1345 1349 1355  
     anomalous 1224 1272 1279 1283 1309 1374 1381 1382  
   atrophy of 1371 1416 1486 1487  
   bacteriophage therapy of 1473 1718  
   bilarziasis of 1525  
   b section of for stone 1684  
   blood supply of 1345 1349 1356  
     anomalies of 1224 1272 12 9 1280 1283 1309 1374 1381 1382 1409 III 1280 1410  
   calcification tuberculous of 149 1509  
   calculus of (see Calculus)  
   capsules fibrous and fatty of 1349 1351 1353 1480  
   carbuncle of 1453 1456 III 1455  
     treatment of 1460 1481  
   carcinoma of (see Carcinoma)  
   conformation of 1356  
   contusion of 1396 1403  
   cystadenoma malignant papillary of 1565  
   cysts of (see Cysts)  
   decapsulation of 1455 1 07 1 08  
   denervation of 1711  
   diet in treatment of 1434  
   diseases of 1405 1629  
   duplication of 145 150 1221 1224  
     operative treatment of 16 0 1693  
   echinococcus disease of 37 1520 1631  
     operative treatment of 1574  
   ectopic 150 151 1219 1378 1380 1381 1683 III 147 167, 1379  
     operative treatment of 1683 1694 III 1681 1683  
   embryology of 1343  
   embryonal adenomyosarcoma of 1441 1553 1759  
   extraperitoneal lumbar exposure of 1658 1660 III 1660-1663  
   fibroma and fibrosarcoma of 1568  
   function of 1384  
     disturbances of following "crush" in junes 1444  
     tests of 46 57 67 121  
   fused, 150 1373  
     asymmetrical, 150 1375 III 147 13 6  
     horseshoe form of 150 1373 1691 III 146 147 13 3 1374 13 5 1691 1692  
     operative treatment of 13 8 16 0 1689 1690 1691  
     unilateral with crossed ectopy 13 8 III 13 9  
   gas bacillus infection of 151  
   gonorrhea of 1512  
   gumma of 1514 III 1513  
   hemangioma of 1569  
   hilum of 1352 1360  
   horseshoe (see Fused)  
   hypernephroma of 1567 1563 1564 1569 15 1  
     treatment of 1573 1 60  
   hypertrophic or compensatory 1369 13 2 1381 III 1368

- hypoplastic 1367 III 146, 1368, 1369-1370 1371
- injuries to*, 170, 1395, III 169, 1397
- operative treatment of, 1695, 1698, III 1696-1698
- innervation of, 1359, 1708
- leiomyoma and leiomyosarcoma of, 1568
- leukoplakia of, 1529
- lipoma and liposarcoma of, 1568
- lobulated or fetal 1372
- lymphatics of, 1359
- "medical" diseases of (see Nephritis Nephrosis)
- movable (see Nephroptosis)
- non operative treatment of, 1715
- non specific infections of, 1450, 1461, 1474
- operative treatment of, 1655
- incisions employed in, 1657
- osteoma of, 1567, III 1567
- palpation of, 13
- pelvis of (see Renal pelvis)
- physiology of, 1384
- polycystic, 56, 1372, 1531, 1545, 1633, III 161, 1533
- treatment of, 1537, 1686
- postoperative care following surgery of, 1669, 1679, 1685, 1686, 1689, 1713, 1715
- complications following surgery of, 1714
- preoperative preparation for surgery of, 1656
- radiation therapy of tumors of 1553, 1560, 1569, 1758 1759, 1760
- relation of, to arterial hypertension, 1439
- replacement lipomatosis of, 1485, III 1486
- rotation of, 1349
- abnormal, 1382
- rupture of 170, 1395, 1399, III 169, 1397
- operative treatment of, 1695, 1698, III 1696-1698
- sarcoma of, 1562, 1563 1567, 1568, 1571
- treatment of, 1573, 1760
- sclerotic diseases of, 1433
- solitary, congenital, 1362 1365, III 1366
- specific infections of, 1487
- staphylococcal focal infections of cortex of, 1453, 1460, 1481, 1630, III 1366
- structure, gross, of 1352
- microscopic, of, 1354
- supernumerary, 1365, III 1366
- supports of, 1352, 1618
- sympathetic surgery of, 1708, 1710
- syphilis of, 1512
- tuberculosis of (see Tuberculosis)
- tumors of (see Tumors)
- typhoid infection of, 1516
- veins of, 1350, 1358
- anomalies of, 1381, 1384, III 1410
- weight of, 1356
- Wilms' tumor of, 1444, 1553, 1569, 1635, 1759
- wounds of, 1398
- Kink of ureter 1219, 1222, 1223, 1224, 1294, 1627
- etiology of, 1277
- pyelography in, 151, 1224, 1279, III 153
- serial pyelogram in, 136, 154, 1279, 1627
- treatment of, 1279
- Kirwin cystoscopic rongeur, 107, 1056; III 107
- lithotrite, 107, III 107
- measuring instrument and radon seed implanter, 1058, 1750, 1751, III 1748, 1752-1757
- method of circumcision, 319, III 321
- method of treating vesical papillomatosis by resection and cauterization with phenol and alcohol, 1146
- Mixture for vesical irritability, 937
- resectoscope, 649, 685 844, 913, 915, 1058, 1065, 1147, III 913, 914, 915
- Kollmann dilator, 661, 882, 908, 1065
- Kraurosis of vulva, 588
- Kretschmer double-exposure roentgenographic method of diagnosing ureteral calculi, 128
- Lacuna magna, 102, 613
- Lavage (see Irrigation)
- Learmonth's technic of presacral neurectomy, 1135
- Leiomyoma of bladder, 1047
- kidney, 1568
- spermatic cord, 464
- testicular tunics, 465
- Leiomyosarcoma of kidney, 1568
- Leucin in urine, 40
- Leukoplakia of bladder, 116, 1019, 1041, Plate II
- treatment of, 1021, 1117
- renal pelvis, 1529
- ureter, 1246, 1252
- vulva, 588
- Lewis's universal operating cystoscope, 105
- Lipoid nephrosis, 430 1435
- Lipoma of kidney, 1568
- scrotum 427
- spermatic cord, 427, 463
- vagina, 599
- vulva, 589
- Lipomatosis replacement, of kidney, 1485, III 1486
- Litholapaxy, 1124 1126
- instruments for, 1126
- technic of, 1128
- Lithotrite, Bigelow, 373, 1126
- Kirwin 107, 1126, III 107
- Littre's glands, 102, 613
- Lobulated or fetal kidney, 1372
- Localized submucous fibrosis of bladder, 1013
- treatment of, 1018, 1113
- Lowsley biopsy instrument, 851, III 852-855
- cystoscopic rongeur, 105, 1056, III 105, 106
- removing bladder stone, 1125, III 1074, 1125
- cystoscopic roentgenographic table, 97, III 99
- cysto-urethroscope 937
- examining table, 97

- Lowsley forward looking urethroscope, 90, 563, 661  
 grasping forceps, 1269, Ill. 666  
 -Hunt cystometer, 82, Ill. 82  
     plication operation for incontinence of urine and feces in male, 1137, Ill. 1140, 1141  
 -Kilgore technic of total prostatectomy, 922, Ill. 923-928  
 method of circumcision, 319, Ill. 320  
     perineal urethrolithotomy, 1321, Ill. 1321  
     repair of recto-urethral fistula, 695, Ill. 691-693  
     repair of vesical orifice for urinary incontinence, 1137, Ill. 1138, 1139  
 modification of Young's conservative perineal prostatectomy, 891, Ill. 893-898, 899-902  
 operation for penoscrotal hypospadias, 340, Ill. 341-347  
     plastic induration of penis, 358  
 -Peterson universal urethroscope 94, 185, 186, 563, 649, Ill. 95-98  
 prostatic tractor (curved), 891, 922, 923, 929, Ill. 899, 900, 901  
 prostatic tractor (short, straight), 923, Ill. 923  
 ribbon gut method of heminephrectomy, 1670, 1691, 1694, Ill. 1672, 1691, 1692  
     ligating friable renal pedicle, 1664, Ill. 1665  
     nephropexy, 1703, Ill. 1701-1705, 1706  
     nephrotomy, 1672, Ill. 1675-1677, 1678  
     repairing kidney wounds, 1698, Ill. 1696-1698  
     plication operation for impotence, 312, 350, Ill. 351-357  
     plication operation for urinary incontinence, 1140, Ill. 1142, 1143  
 -Wang instrument for intravesical irradiation and treatment of tuberculous sinuses, 1199, Ill. 1200  
 Lues (see Syphilis)  
 Lumbar puncture, 277  
 Luxation of testicle, 409  
 Lymphangioma of spermatic cord, 464  
 Lymphangitis in chancroid, 262  
     gonorrhea, 710  
 Lymphatics of bladder, 957  
     Cowper's gland, 736  
     epididymis, 373  
     kidney, 1359  
     penis, 229, 323  
     prostate, 797  
     scrotum, 229, 367  
     seminal vesicle, 525  
     testicle, 373, 499  
     ureter, 1212, 1452  
     urethra, female, 615, 750  
         male, 325, 615  
     vas deferens, 373  
 Lymphogranuloma venereum, 280  
     differential diagnosis of, 264, 283  
     Frey test for, 283, 597  
     in female, 597  
     treatment of, 286  
 Lymphogranulomatosis of penis, 283, 304  
     testicle, 462  
 Malakoplakia of bladder, 1021  
 Malecot self retaining catheter, 75, 1312, 1313  
 Malignant tumors (see Tumors)  
 Mandelamine, 1178, 1472  
 Mandelic acid, 567, 644, 939, 1006, 1008, 1472, 1611  
     characteristics of, 1179  
 Massage of prostate, 18, 814, 817, 935  
     bimanual method of, 936  
     seminal vesicle, 546, 564  
 McCarthy baby cystoscope, 122  
     ejaculatory-duct catheterizing instrument, 185, 563  
     observation and operating cysto-urethroscope 88  
     resectoscope, 913, Ill. 916-919  
 Meatotomy, 617, 663, 753, 773  
     technic of, 673  
 Meatus urinary in female, 750, 755, 771, 773  
     structure of, 751, 752, 755  
     syphilitic chancre of, 765  
     in male, 226, 613  
     accessory, 628  
     imperforation of, 616  
     stenosis of, 617, 663, 673  
 Median bar obstruction of vesical neck, 842  
     resection of, 844  
 "Medical" diseases of kidney (see Nephritis Nephrosis)  
 Megalo-ureter, 1219, 1222, 1224, 1227, 1294  
     etiology of, 1291  
     treatment of, 1293  
 Meningitis tuberculous, 1511  
 Mesonephros, 362, 1343, 1344  
 Metanephros, 1343, 1345  
 Methenamine, 546, 567, 885, 939, 1006, 1007, 1472, 1611  
     characteristics of, 1177  
 Methylene blue, 507, 508, 1178  
     test of renal function, 48  
 Micturition, 968  
     effects of nerve sections upon, 974  
     innervation of, 969  
     musculature of, 968  
     physiology of, 974  
 Monorchidism, 376  
 Morphological rests of testicle, 361, 375  
 Mosenthal diet test of renal function, 49  
 Movable kidney (see Nephroptosis)  
 Multilocular renal cyst (see Cyst)  
 Multiple hemorrhagic sarcoma (Kaposi's disease) of penis, 299  
 Musculature of bladder, 945, 948, 950, 952, 968  
     micturition, 968

- penis, 227  
 prostate gland, 787, 793  
 ureter, 1211  
 urethra, female, 750, 769  
   male, 612, 613, 614, 968, 969  
 Myogenic bladder, 980  
 Myoma of bladder, 1047  
   urethra, female, 769  
   male, 649  
 Myxoma of bladder, 1047  
   epididymis, 465  
   renal pelvis, 1546  
   spermatic cord, 464  
   testicular tunics, 465
- Nephralgia, 1629  
   decapsulation for, 1707  
   renal sympathectomy for, 1708
- Nephrectomy, 1659  
   extraperitoneal lumbar, 1658, 1660, III  
     1660-1663  
   for tuberculosis, 1666  
   *handling of vascular pedicle in*, 1663  
   using ribbon gut, 1664, III. 1665  
   postoperative care following, 1669  
   resection of twelfth rib in 1666, III 1666  
   subcapsular, 1664  
   transperitoneal, 1668, III 1667, 1668
- Nephritis, 1423, 1514  
   *acute diffuse glomerular*, 30, 1424  
   blood chemistry tests in, 55, 59  
   chronic diffuse glomerular, 1428  
   classification of, 1423, 1424  
   diet in, 1434  
   hypertension in, 1439  
   parenchymatous, 40  
   renal decapsulation for, 1435, 1707  
   staphylococcal suppurative, 1453, 1460  
   subacute diffuse glomerular, 1425  
   treatment of, 1433, 1435, 1707  
   uremia in, 1437, 1438
- Nephrolithiasis (see Calculus)
- Nephropexy, Deming method of, 1707  
   indications for, 1629  
   Lowsley ribbon gut method of, 1703, III  
     1701-1705, 1706
- Nephroptosis, 136, 151, 1278, 1279, 1411,  
   1617, III 153  
   diagnosis of, 1625  
   etiology of, 1619  
   serial pyelography in, 1626  
   treatment, non-operative, of, 1628  
   by operation, 1629, 1699, 1703, 1707,  
     III 1701-1705, 1706
- Nephrosis, 1423, 1429  
   amyloid, 29, 1432  
   chemical, 1432  
   diet in, 1434  
   hypertension in, 1439  
   lipoid, 1430, 1435  
   of pregnancy, 1432  
   treatment of, 1433  
   by renal decapsulation, 1435  
   uremia in, 1435, 1438
- Nephrostomy for permanent drainage, 1673,  
   1685
- Nephrotomy, 1672  
   postoperative care following, 1679  
   using ribbon gut, 1673, 1674, 1679, III  
     1675-1677, 1678
- Nephro-ureterectomy, 1669
- Nerves (see Innervation)
- Neuralgia of testicle and epididymis, 449
- Neuroblastoma of adrenal gland, 1579
- Neurofibromatosis of bladder, 1048
- Neurogenic abnormalities of bladder, 979,  
   1084, 1161  
   clinical types of, 1085  
   cystometrograms in, 978  
   treatment of, 1088
- Nitrazine test for pH of urine, 33
- Noma vulvae, 591
- Non-operative treatment of bladder, 1158  
   inoperable and postoperative urogenital  
     tuberculosis, 1196  
   kidney, 1715  
   prostate, 935  
   scrotum and scrotal contents, 517  
   vas deferens, seminal vesicle, and ejacu-  
     latory duct, 562
- Non protein nitrogen, tests of blood for, 59
- Non specific infections of Cowper's gland, 737  
   epididymis, 438, 475, 517  
   differential diagnosis of, 439  
   treatment of, 440, 517  
   kidney and renal pelvis, 1450, 1461, 1474  
   prostate gland, 806, 809, 818  
   treatment of, 809, 816  
   seminal vesicle, 535, 546  
   ureter, 1239  
   urethra, female, 755  
   treatment of, 759  
   male, 643, 717  
   vas deferens, 530
- Obturator, urethral, 77
- Oliguria, 7, 29
- Ombredanne's operation for hypospadias, 336
- Operative treatment of bladder, 1102  
   Cowper's gland, 743  
   female external genitalia, 602  
   kidney, 1655  
   incisions employed in, 1657  
   penis, 318  
   prostate, 878  
   scrotum and scrotal contents, 486  
   seminal vesicle, 560  
   ureter, 1302  
   urethra, female, 781  
   male, 672  
   vas deferens, 486, 556
- Orchidectomy, 461, 498, 1737  
   for carcinoma of prostate, 498, 858  
   torsion of testicle, 495
- Orchidopexy, 487  
   authors' method of, 488, III 489, 490, 493  
   for ectopic testis, 495, III 495, 496, 497,  
     499

- Orchidopexy, indications for, 487  
 Torek technic of, 490
- Orchitis, acute, 433, 434  
 chronic, 433  
 of mumps, 5, 434, 435, 475  
 syphilitic, 446  
 treatment of, 435, 517
- Organ of Giraldes, 375
- Os penis, 295, 296
- Osteoma of kidney, 1567, Ill. 1567
- Paget's disease of glans penis, 290, 301
- Palpation of bladder, 15  
 epididymis, 19  
 kidney, 13  
 penis, 19  
 rectal, 15, 54, 813, 819, 824, 850  
 testicle, 19  
 ureter, 15
- Papilloma of bladder, 118, 1039, 1050, 1051,  
 1060, Plate IV  
 treatment of, 1057, 1146  
 penis, 296  
 renal pelvis, 1546, 1547  
 treatment of, 1552  
 ureter, 1252  
 treatment of, 1257, 1758  
 urethra, female, 766  
 male, 648
- Papillomatosis of bladder, 1039, 1050, 1051,  
 Ill. 1040, Plate IV  
 treatment of, 1057  
 by Kirwin's method of resection and cau-  
 terization with phenol and alco-  
 hol, 1146
- Paradidymus, 375
- Paralytic bladder, 1086, 1087  
 treatment of, 1088
- Paraphimosis, 253, Ill. 254  
 gangrene caused by, 254, Ill. 258  
 treatment of, 254, Ill. 255
- Paraneuritic abscess, 1480
- Paraurethral abscess, 710, 711, 713
- Pediculosis pubis, 414
- Pelouze bodies in tuberculosis, 640
- Penicillin, 939, 1181  
 infections responsive to, 1185, 1520  
 modes of administering, 1183  
 therapy of gonorrhea, 720, 1185
- Penis, 223, 245, 318  
 absence, congenital, of, 230, 615  
 adherent, 225, 230, 233  
 amputation of for carcinoma, 303, 323,  
 656, 657, Ill. 324-331  
 anatomy of, 226  
 anesthesia for surgery of, 217, 318, 319  
 angoma of, 298  
 anomalies, congenital, of, 229  
 arteries of, 228, 356  
 blood supply of, 228  
 bone formation (os penis) in, 295, 296  
 carcinoma of (see Carcinoma)  
 chancre of (see Syphilis)  
 chancroid of, 261, 263, 278, 283  
 chordee of, 335, 340, 344, Ill. 337, 338, 344  
 concealed, 230  
 condyloma acuminata of, 296  
 condyloma lata of, 297  
 constriction of, 251, Ill. 252  
 contusion of, 247  
 cutaneous affections of, 256, 414  
 dartos of, 227  
 denudation of, 250  
 diphtheria of, 288  
 diseases of, 252  
 dislocation of, 251  
 duplication of, 231, Ill. 233  
 elephantiasis of, 283, 292, 426, Ill. 292  
 embryology of, 223  
 erection of, 241, 527  
   pathological (see Priapism)  
 fibroma of, 295  
 gangrene of, 254, 259, 419, Ill. 258  
 glans of (see Glans)  
 gumma of, 295  
 hematoma of, 247, Ill. 248  
 herpes progenitalis of, 287  
 injuries of, 245, 308, 334  
 innervation of, 228, 241, 356  
 integuments of, 226  
 lymphatics of, 229, 323  
 lymphogranulomatosis (Hodgkin's dis-  
   ease) of, 283, 304  
 multiple hemorrhagic sarcoma (Kaposi's  
   disease) of, 299  
 muscles of, 227  
 operative treatment of, 318  
 palpation of, 19  
 papilloma of, 296  
 physiology of, 241  
 plastic induration (Peyronie's disease) of,  
   293, 358  
 postoperative care of, 322, 333  
 preparation of patient for surgery of, 318,  
   319, 327  
 Queyrat's erythroplasia of, 289, 301  
 radiation therapy of tumors of, 303, 1744  
 raphe of, 224, 225, 360, 608  
   congenital cysts and canals of, 240  
 rudimentary, 230, 615  
 rupture (fracture) of, 249, 250  
 sarcoma of, 298  
 scabies of, 414  
 suspensory ligament of, 227, 335, Ill. 356  
 syphilis of (see Syphilis)  
 tuberculosis of, 279, 283, 287, 288  
 tumors of (see Tumors)  
 urticaria of, 256  
 veins of, 228, 356  
 wounds of, 245, 247, Ill. 246
- Perineal prostatectomy (see Prostatectomy)
- Perineuritic abscess, 1455, 1480, 1497, 1510  
 diagnosis of, 1484, 1630  
 operative treatment of, 1460, 1485, 1689  
 postoperative care of, 1689
- Perinephrium, 1480

- Perineum, musculature of*, 969  
 raphe of, 224, 360, 608  
 congenital cysts and canals of, 240  
*removal of ureteral calculus through*,  
 1322, Ill 1321  
*transplanting urethra into, after amputa-  
 tion of penis for cancer*, 332,  
 Ill 329, 330, 331
- Peristalsis of ureter*, 145, 1226, 1310, 1313
- Periurethral abscess in female*, 758, 760, 761  
 in male, 645, 710, 713  
 excision of, 646, Ill 646  
 fistula resulting from, 647, Ill 647
- Peroral (excretory) urography*, 142
- Peyronie's disease of penis (see Plastic in-  
 duration)*
- Pezzer self retaining catheter*, 75
- pH of urine*, 32, 1605  
 tests for determining, 32
- Phenolsulphonphthalein test of renal func-  
 tion*, 46, 121
- Pheochromocytoma of adrenal gland*, 1580
- Phimosis, acquired*, 252, Ill 254  
 treatment of, 253  
 • as predisposing factor in penile cancer, 300  
 in preputial calculus, 309  
 congenital, 232  
 treatment of, 234
- Phloridzin test of renal function*, 49
- Physical examination, general*, 11  
 of urogenital tract, 12  
 tests of urine, 27
- Physiology of adrenal gland*, 1575  
 bladder, 968, 974  
 Cowper's gland, 736  
 ejaculatory duct, 526  
 kidney, 1384  
 micturition, 974  
 penis, 241  
 prostate, 801  
 scrotum, 384  
 seminal vesicle, 526  
 testicle, 385  
 ureter, 1226  
 urethra, female, 753, 968  
 male, 629, 968  
 vas deferens, 526
- Pilcher prostatectomy bag*, 891
- Plastic induration (Peyronie's disease) of  
 penis*, 293, 358  
*differential diagnosis of*, 295  
 treatment of, 295, 358
- Pneumoperitoneum*, 171
- Poggi's method of ureteral anastomosis*, 1317
- Polycystic kidney*, 56, 1372, 1531, 1633,  
 Ill 161, 1533  
 diagnosis of, 1536, 1545  
 etiology of, 1532  
 familial occurrence of, 1532  
 incidence of, 1531  
 treatment of, 1537, 1686
- Polyorchidism*, 376
- Polyp of ureter*, 1253, Ill 1253
- urethra, female*, 758, 766  
 male, 648  
 vagina, 598
- Polyuria*, 6, 7, 29, 50
- Postoperative anuria*, 786  
 care following surgery of bladder, 1116,  
 1149  
 Cowper's gland, 746  
 female external genitalia, 605  
 kidney, 1669, 1679, 1685, 1686, 1689,  
 1713, 1715  
 penis, 322, 333  
 prostate, 903, 908, 917  
 scrotum and scrotal contents, 494, 49,  
 499, 503, 510, 512, 513, 517  
 transurethral resection of prostate, 917  
 ureter, 1169, 1314, 1335  
 ureteropelvic junction, 1314  
 urethra, female, 785  
 male, 699  
 complications in prostatectomy, 906  
 surgery of bladder, 1149  
 kidney, 1714  
 scrotum and scrotal contents, 517  
 transurethral resection of prostate,  
 917  
 cystitis, 995  
 treatment of urogenital tuberculosis, 1196
- Preaortic lymph nodes*, 373
- Pregnancy, Aschheim Zondek test for*, 43  
 cystitis in, 996  
 nephrosis in, 1432  
 pyelonephritis of, 1471, 1474  
 treatment of, 1479, 1716
- Preoperative preparation of patient for pros-  
 tatectomy*, 880, 883  
 surgery of bladder, 1102  
 Cowper's gland, 743  
 female external genitalia, 602  
 kidney, 1656  
 penis, 318, 319, 327  
 prostate, 880  
 scrotum and scrotal contents, 486  
 seminal vesicle, 560  
 ureter, 1169, 1302, 1335  
 urethra, female, 781  
 male, 672  
 vas deferens, 556, 560  
 transurethral resection of prostate, 880,  
 911  
 roentgenography in urinary calculus, 1324
- Prepuce, adherent*, 225, 233  
 anatomy of, 227, 228  
 calculus of, 234, 309  
 development of, 225  
 frenum of, 225, 227  
 redundant, 232, 234, 259, 261  
 sebaceous glands of, 227  
 sphincter of, 227
- Presacral neurectomy, indications for*, 1088,  
 1134  
 technic of, 1135

- Pnaphism, 305  
   treatment of, 308  
 Prolapse of bladder in female, 1064  
   ureter, 1286, 1290  
   urethra, female, 103, 755, 756, 773, 777  
   treatment of, 774, 783  
 Pronephros, 1343  
 Prophylaxis, chemical, for venereal disease, 264, 718, 762  
 Prostate gland, 787, 804, 878  
   abscess of, 808, 809, 811, 813, 818, III. 808  
   operative treatment of, 819, 929, III. 930, 931, 933  
   absence, congenital, of, 800  
   adenocarcinoma of, 847, III. 848, 849  
   anatomy of, 792  
   anesthesia for surgery of, 218, 878  
   anomalies, congenital, of, 800  
   arteries of, 796  
   bacteriophage therapy of, 817, 937  
   bilharziasis of, 825  
   biopsy of, 851, III. 852-855  
   blood supply of, 796  
   calculus of (see Calculus)  
   capsule of, 792, 793  
   carcinoma of (see Carcinoma)  
   contiguous structures of, 798  
   cysts of, 824, 826  
   diet in treatment of, 816, 885, 908, 938  
   diseases of, 806, 870  
   embryology of, 787, III. 788, 789  
   fascial investments of, 795  
   fibrosis, chronic, of, 921  
   gonorrheal infection of, 710, 712, 713, 724, 806, 810, 818  
   hypertrophy of (see Hyperplasia)  
   injuries to, 805  
   innervation of, 793, 798  
   interrelation of, to testis and hypophysis, 390, 827  
   lymphatics of, 797  
   massage of, 18, 814, 817, 935  
   microscopic structure of, 792  
   musculature of, 787, 793  
   non-operative treatment of, 935  
   non-specific infections of, 806, 809, 818  
   operative treatment of, 878  
   physiology of, 801  
   postoperative care following surgery of, 903, 908, 917  
   complications in surgery of, 906, 917  
   preoperative preparation for surgery of, 880, 883, 911  
   pyemia, chronic, of, 920  
   radiotherapy of benign hyperplasia of, 1745  
   tumors of, 858, 1747, III. 1748  
   rectal palpation of, 151, 541, 813, 819, 824, 850  
   rhabdomyosarcoma of, 862, 863, 865  
   sarcoma of, 860, III. 860-862, 864  
   treatment of, 865  
   secretion of, 19, 802, 815  
   microscopic study of, 18, 541, 716, 814  
   secretory function of, 801  
   subsidiary glands of, 792, 799  
   syphilis of, 820  
   transurethral resection of (see Trans-urethral)  
   trichomonas vaginalis infestation of, 824  
   tuberculosis of (see Tuberculosis)  
   tumors of (see Tumors)  
   vaccine therapy of, 817, 937  
   veins of, 797  
   weight of, 795  
 Prostatectomy, control of hemorrhage following, 891, 901, 907  
   cystostomy preliminary to, 883, 886, 891  
   hemostatic bags, 891  
   indications for, 880  
   perineal, 858, 881, 891  
   anesthesia for, 218, 879  
   Belt's approach in, 898  
   plication of external sphincter following, 897, III. 902  
   technic of, 891, III. 893-898, 899-902  
   vasectomy preliminary to, 557, 891  
   postoperative care following, 903, 908, 917  
   complications of, 906, 917  
   preoperative preparation for, 880, 883  
   selection of patients for, and technic of, 880  
   suprapubic, 881, 887  
   anesthesia for, 879  
   Fuller Freyer technic of, 887, III. 888, 889, 890, 892  
   vasectomy preliminary to, 557, 887  
   total perineal, 920  
   indications for, 857, 882, 920, 932  
   Lowsley Kilgore technic of, 922, III. 923-928  
   Young's method of, 922  
 Prostatitis, acute, 806, III. 807  
   treatment of, 808  
   chronic, 809  
   diagnosis of, 813  
   examination of prostatic fluid in, 814  
   treatment of, 816, 920  
 Prostatotomy for prostatic abscess, 931, III. 933  
   calculus, 932, III. 934  
 Prunio of scrotum, 415  
 Prunus scroti, 416  
   vulvae, 589  
 Pseudohermaphroditism, 381, III. 341-347  
 Pseudomembranous cystitis, 1002  
 Purpura of bladder, 117  
 Pyelitis 1461, III. 1462  
   in children, 1461, 1463, 1465, 1630  
   of pregnancy, 1471, 1474, 1479, 1716  
   symptoms of, 1466  
   treatment of, 1471  
 Pyelitis cystica, 1243  
 Pyelography (see Excretory urography; Retrograde pyelography)  
 Pyelograms, interpretation of, 143  
 Pyelonephritis, 1461  
   atrophic, 1466, 1470  
   diagnosis of, 1468



- factors predisposing to, 1464, 1630  
hypertension in chronic 1443  
of pregnancy, 1471, 1474, 1479, 1716  
pathology of, 1465, 1481  
treatment of, 1471, 1716
- Pyelostomy, 1679, 1685
- Pyelotomy, 1679  
for calculus, 1606, 1679, III 1681  
transperitoneal, in ectopic kidney, 1683,  
III 1681-1683
- Pyocele 469, 470
- Pyonephrosis, 1461, 1462, 1481  
factors predisposing to, 1464  
pathology of, 1466  
treatment of, 1471, 1473
- Pyndium 567, 885, 1008, 1179
- Pyuria, 28, 36
- Queyrat's erythroplasia of penis, 289, 301
- Radiation therapy, historical review of,  
1724  
methods of applying, 1731  
with Kirwin measuring instrument and  
radon seed implanter, 1058, 1750,  
1751, III 1748, 1752-1757  
of genito-urinary tract (general discussion),  
1733  
of malignant tumors of bladder, 1057,  
1110, 1147, 1750 III 1111, 1148,  
1753, 1754 1757  
Cowper's gland 743, 1743  
penis, 303, 1734  
prostate, 858, 1747, III 1748  
renal parenchyma in adults, 1573, 1760  
in children, 1560, 1759  
renal pelvis and ureter, 1553, 1560,  
1758  
scrotum, 431, 1736  
seminal vesicle and spermatic cord,  
551, 1739  
testicle, 387, 462, 1736  
urethra, female, 770, 1744  
male, 656, 657, 1742  
vagina, 599, 600, 1739  
vulva, 591, 1739  
Wilms' tumor, 1560, 1759  
of prostatic hyperplasia, 1745
- Radical removal of genital tract for tu  
berculosis 510
- Radium and x ray burns of bladder, 993  
therapy (see Radiation)
- Raphe, penile, 224, 225, 360, 608  
penoscrotoperineal, cysts and canals of,  
240  
perineal, 224, 360, 608  
scrotal, 224, 360 376
- Rectal palpation, 15, 341, 813, 819, 824, 850
- Recto-urethral fistula (see Fistula)
- Redundant prepuce, 232, 234, 259, 261  
renal pelvis resection of, 1313 1404, III  
1308  
scrotum, amputation of, 513
- Reensterno skin test for chancroid, 262
- Reflux, vesico-ureteral, 1228
- Reimplantation of ureter into bladder, 1303,  
1316, 1318, III 1319
- Renal arteriography, 171  
ballotement, 14  
blood vessels, anomalies of (see Anomalies)  
factor in arterial hypertension, 1439  
function, disturbances of following 'crush'  
injuries 1444  
tests of (see Tests)
- pelvis, anatomy of, 1352  
delayed emptying of, serial pyelograms  
for determining, 133, 137, III 134  
duplication of, 145, 1215, 1223, III 146,  
149  
embryology of, 1208, 1346  
inflammations of (see Pyelitis Pyelo-  
nephritis)  
injuries of, 1403  
irrigations of, 1473, 1611, 1715, 1716  
leukoplakia of, 1529  
non specific infections of, 1450, 1461,  
1474  
normal, pyelographic appearance of,  
143, III 144  
papilloma of, 1546, 1547, 1552  
radiation therapy of tumors of, 1553,  
1560, 1758  
resection of redundant, 1313, 1404,  
III 1308  
rupture of, 1403  
tumors of (see Tumors)
- rickets, 1447  
treatment of, 1449
- sympathectomy, 1708 1710
- Replacement lipomatosis of kidney, 1485,  
III 1486
- Resectoscopes, types of, 913, III 913-919
- Residual urine, determination of, 81
- excretory urography as measure of, 171
- Retrograde pyelo-ureterography, 112, 122,  
129  
care of patient following, 122  
complications of 132  
contrast media for, 131  
in children, 123  
indications and contraindications for, 130  
preparation of armamentarium for, 112  
of patient for, 113  
serial method of, 133, III 133 134  
advantages of, 135, 154, 1420, 1626  
technic of, 135  
technic of, 131
- Retroperitoneal abscess, 1481, III 1481, 1482
- Retzius, space of, 635, 947, 990
- Rhabdomyoma of bladder, 1047  
renal pelvis, 1546
- Rhabdomyosarcoma of prostate, 862, 863,  
865  
spermatic cord, 464
- Ribbon gut, 1673  
use of, for ligating friable renal pedicle  
in nephrectomy, 1664, III 1665  
for plugging external sphincter follow  
ing perineal prostatectomy, 897,  
III 902

- Ribbon, gut, use of, in calyceal resection, 1684  
 heminephrectomy, 1670, 1691, 1694, Ill. 1672, 1691, 1692  
 nephropexy, 1703, Ill. 1701-1705, 1706  
 nephrotomy, 1672, Ill. 1675-1677, 1678  
 plication operation for impotence, 312, 350, Ill. 351-357  
 plication operation for incontinence of urine in female, 1140, Ill. 1142-1143  
 plication operation for incontinence of urine and feces in male, 1137, Ill. 1140, 1141  
 repair of kidney injuries, 1698, Ill. 1696-1698  
 repair of vesical orifice following total perineal prostatectomy, 928, Ill. 927, 928
- Rickets, renal, 1447  
 treatment of, 1449
- Roentgen therapy (see Radiation)
- Roentgenograms, plain, of bladder, 129, Ill. 180  
 extra urinary abnormalities, for differential diagnosis, 127, Ill. 161, 162, 167  
 genito-urinary tract, 125  
 preparation of patient for, 125  
 routine method of securing, 126  
 kidney, 126, Ill. 149, 165  
 prostate, 129  
 ureter, 128  
 urethra, male, 129  
 postoperative, in urinary calculus, 1324  
 preoperative, in urinary calculus, 1610
- Rotation of kidney, 1349  
 abnormal, 1382
- Rudimentary penis, 230 615
- Rupture of bladder, 118, 179, 182, 918, 988, Ill. 989  
 cystography in, 182, 992  
 excretory urography in, 179, 992  
 operative treatment of, 992 1120  
 kidney, 170, 1395, 1399, Ill. 169, 1397  
 diagnosis of, 1401  
 operative treatment of, 1695, 1698, Ill. 1696, 1697, 1698
- penis, 249  
 treatment of, 250
- renal pelvis, 1403
- testicle, 407
- tunica vaginalis in hydrocele, 404
- ureter, 170 1232, 1315
- urethra, male, 634, 679  
 operative treatment of, 637, 679, 684, Ill. 682, 683  
 postoperative dilatation in, 685  
 with extravasation of urine, 635  
 operative treatment of, 637, 679, 684, Ill. 680, 681
- Sacral and parasacral anesthesia (see Anesthesia)
- Sarcoma of bladder, 1038, 1039, 1046, 1050, 1055, 1057, 1093  
 kidney, 1562, 1563, 1567, 1568, 1571  
 treatment of, by surgery and radiation, 1573, 1760
- penis, 298  
 multiple hemorrhagic (Kaposi's disease), 300
- prostate, 860, Ill. 860-862, 864  
 treatment of by surgery and radiation, 865
- renal pelvis, 1546
- spermatic cord, 463, 464
- ureter, 1252
- urethra, female, 770  
 male, 656, 668
- vagina, 600, 1740
- vulva, 591, 1740
- Scabies of scrotum and penis, 414
- Scarpa's triangle, 229, 323
- Schistosoma haematobium infestation (see Bilharziasis)
- Sclerotic diseases of kidney, 1433
- Scrotum, 360, 400, 486  
 abscess of, 423  
 incision and drainage of, 423, Ill. 423  
 anatomy of, 365  
 anesthesia for surgery of, 218, 486  
 anomalies, congenital, of, 375  
 arteries of, 366  
 bilobate, 375  
 blood supply of, 366  
 calcified sebaceous cysts of, 432  
 calculi and concretions of, 431  
 carcinoma of, 429, 431, 1736  
 chancre, syphilitic, of, 417  
 chancroid of, 417  
 condyloma lata of, 417, 418  
 contusion of, 400  
 cutaneous affections of, 256, 414  
 dartos of, 365, 366, 367  
 diseases of, 414  
 elephantiasis of, 292, 417, 424, 426, Ill. 292  
 embryology of, 360  
 epithelioma of, 429, 431, 1736  
 gangrene of, 404, 405, 419, Ill. 420  
 granuloma inguinale of, 419  
 gumma of, 418  
 hematoma of, 401, 404, 431, 473, Ill. 248  
 injuries of, 400  
 innervation of, 367  
 lipoma of, 427  
 lymphatics of, 229, 367  
 non-operative treatment of, 517  
 operative treatment of, 486  
 pediculosis of, 414  
 physiology of, 384  
 postoperative care following surgery of, 516  
 preoperative preparation for surgery of, 486  
 prurigo of, 415  
 pruritus of, 416  
 radiation therapy of tumors of, 431, 1736  
 raphe of, 224, 360 376  
 cysts and canals, congenital, of, 240  
 redundant, amputation of, 513

- scabies of, 414  
 sebaceous cysts of, 428, Ill 428  
   calcified, 432  
 suspensory for support of, 519, Ill 518  
 syphilis of (see Syphilis)  
 tumors of (see Tumors)  
 veins of, 366  
 wounds of, 400  
 Sebaceous cysts of scrotum, 428, Ill 428  
   calcified, 432  
   vulva, 589  
 Sebaceous glands of prepuce, 227  
 Secretion of Cowper's gland 736  
   prostate, 18, 541, 716, 802, 814  
   seminal vesicle, 18, 525, 526, 541, 565, 716, 814  
   testicle 369, 385, 386  
 Seminal fluid, 525, 526  
   microscopic examination of, in sterility, 476  
 Seminal vesicle, 361, 529, 560  
   abscess of, 548, 550  
   absence, congenital, of, 526  
   anatomy of, 524  
   anesthesia for surgery of, 218, 560  
   anomalies, congenital, of, 526  
   applying heat to, methods of, 566  
   arteries of, 525  
   bacteriophage therapy of, 546, 567  
   calcification of, 532, 552  
   calculus of, 552, Ill 552  
   carcinoma of, 550 551, 1739  
   diseases of, 535, 553  
   duct of, 523, 524, 525  
   embryology of, 361, 521  
   gonorrheal infection of, 535, 546, 710, 712, 713, 724  
   injuries of, 529  
   innervation of, 525  
   lymphatics of, 525  
   massage of, 546, 564  
   non-operative treatment of 562  
   non specific infections of, 535, 546  
   normal, vesiculographic appearance of, 539, Ill 539  
   operative treatment of, 560  
   physiology of, 526  
   preoperative preparation for surgery of, 560  
   radiation therapy of tumors of, 551, 1739  
   rectal palpation of, 17, 541  
   secretion of, 525, 526  
     examination of, 18, 541, 565, 716, 814  
   stripping of, 18, 541, 546, 566  
   syphilis of, 547  
   tuberculosis of (see Tuberculosis)  
   tumors of (see Tumors)  
   vaccine treatment of, 546, 567  
   veins of, 525  
 Seminal vesiculectomy, 510, 561  
   technic of, 561  
 Seminal vesiculitis, 535  
   clinical forms of, 538, Ill 542, 543  
   diagnosis of 540  
   differential diagnosis of, 545  
   gonorrheal, 535, 546, 710, 712, 713, 724  
   pathology of, 536  
   treatment of, 546, 562  
 Seminal vesiculography, 185, Ill 539, 542, 543  
   after-care following, 187  
   indications for, 185, 477, 545, 550  
   technic of, 186  
 Seminal vesiculotomy, 560  
   technic of, 561  
 Seminoma of testicle, 451, 453  
 Serial pyelo-ureterography, 133, Ill 133, 134  
   advantages of, 135, 154, 1420, 1626  
   technic of, 135  
 Seven glass test of urine, 26  
 Simple cyst of kidney (see Cysts)  
 Sims' operation for vesicovaginal fistula, 1129  
 Sinus epididymus, 366  
   pocularis (see Utricle, prostatic)  
   renalis, 1352  
 Skene's gland, 750, 756, 757, 758  
   abscess of, 760, 761, 762, 782  
   adenocarcinoma of, 769  
   electrocauterization of, 782  
   excision of, 782, Ill 882  
 Smegma preputii, 227, 234, 253, 309, Ill 254  
 Smithwick's method of splanchnic resection, 1711  
 Sodium hypobromite test for quantitative estimation of urea, 51  
 Solitary kidney, congenital, 1362, Ill 1363  
   treatment of, 1365  
   cyst of kidney (see Cysts)  
 Sounds, urethral, 71, 661  
   technic of passing, 73  
 Specific gravity of urine, 30, 50  
 Spermatic cord, anatomy of, 373  
   anesthesia for surgery of, 218, 486  
   dermoid cysts of, 464  
   embryology of, 363, 364  
   fibroma of, 463  
   hydrocele of, 468, 470  
   leiomyoma of, 464  
   lipoma of, 427, 463  
   lymphangioma of, 464  
   operative treatment of, 486  
   preoperative preparation for surgery of, 486  
   sarcoma of, 463, 464  
   torsion of, 411, 413, 487  
   orchidectomy for, 495  
   tumors of (see Tumors)  
 Spermatocele, 445, 473  
   fluid, 474  
   treatment of, by aspiration and injection, 511  
   extirpation, 513, Ill 514, 515  
 Sphincter, external (urethral), 614, 793, 897, 902, 968, 973, 976, 979  
   plication of, following penile prosta-  
   tectomy, 897, Ill 902  
   internal (vesical), 614, 793, 906, 945, 952, 968, 971, 976, 979  
   of prepuce, 227

- Spina bifida, incontinence of urine in, 1091, 1092
- Spinal anesthesia (see Anesthesia)
- Splanchnic resection for arterial hypertension, 1711
- Spontaneous fulminating gangrene of scrotum and penis, 419
- Staining urinary specimens, 38, 39
- Staphylococcus focal infection of renal cortex, 1453, 1481, 1630
- diagnosis of, 1458
- treatment of, 1460
- Stedman motor suction pump, 1152, III 1153
- Stenosis of ureteropelvic junction (see Structure)
- ureterovesical orifice, 151, 1219, 1220, 1272, 1284, 1294, 1296
- treatment of, 1269, 1276, 1277
- by operation, 1304, III 1305
- urinary meatus, female, 751, 752, 755
- male, 617, 663, 673
- vagina, 598
- Sterility in male, causes of, 475
- epididymo-vasotomy for, 505, 508, III 507, 509
- microscopic study of semen in, 476
- treatment of, 477, 505
- Streptococci balanopreputial intertrigo, 257
- Structure of ejaculatory duct, 477, 553, 565
- ureter, 1260, 1270, 1409
- acquired, 1271
- congenital, 150, 1219, 1271
- differential diagnosis of, 1275
- pyelo-ureterogram in, 151, 1275, III 153
- serial pyelogram in, 135
- sex and age incidence of, 1271
- symptoms of, 1277
- treatment of, by dilatation, 1276
- surgery, 1277
- ureteropelvic junction, 1282, III 153
- associated with anomalous renal blood vessels, 1280, 1309
- diagnosis of, 1282, 1309
- operative treatment of, 1283, 1305, 1311, III 1307, 1308
- ureterovesical orifice, 151, 1219, 1220, 1272, 1284, 1294, 1296
- treatment of, 1269, 1276, 1277, 1304, III 1305
- urethra, female, 183, 771
- congenital, 751, 752, 771
- senile, 772
- treatment of, 753, 772, 773
- urethra, male, 103, 657, 918
- congenital, 13, 617, 658
- etiology of, 640, 657, 712
- spasmodic, 657
- treatment of, by dilatation, 661, 673
- electrosurgery, 678
- external urethrotomy, 662, 667, 675
- internal urethrotomy, 662, 674
- resection, 676, III 677, 678
- urinary meatus, in female, 751, 752, 755
- male, 617, 663, 673
- vas deferens, 475, 477, 532
- Stripping of seminal vesicle, 18, 541, 546, 566
- Stylets, ureteral, 85
- urethral, 77
- Subarachnoid injection of alcohol for bladder pain, 1195
- Subcapsular nephrectomy, 1664
- Subcervical glands (of Albarran), 792, 799
- 831, 842, 934
- Subcutaneous excretory urography, 141
- Subtotal and total paravertebral sympathectomy for arterial hypertension, 1712
- Sublingual glands (of Home), 792, 800, 949
- Suction drainage of bladder, suprapubic, 1150, 1151, III 1150-1153
- pump, Stedman, 1152, III 1153
- Sugar in urine, tests for, 30
- Sulfadiazine, 1167, 1171
- Sulfaguanidine, 1169, 1335, 1336
- Sulfanilamide, 1103
- Sulfapyridine, 1165, 1171
- Sulfasuxidine, 1335, 1336
- Sulfathiazole, 1166, 1171
- Sulfonamides, 1162, 1171
- calculus due to, 1171
- general rules for therapy with, 1174
- in treatment of chancroid, 266
- cystitis, 1006, 1007, 1012
- gonorrhea in female, 763
- male, 717, 719, 722, 724, 727
- gonorrheal vulvovaginitis in children, 592
- lymphogranuloma venereum, 286
- non specific urethritis in female, 759
- prostatic infections, 885, 938
- renal infections, 1472, 1611
- seminal vesiculitis and abscess, 546, 550, 567
- wounds of testicle and epididymis, 407
- local use of, in chancroid, 266
- gonorrhea in female, 763
- surgical wounds, 1169, 1314
- surgically drained prostatic abscesses, 931
- method of determining concentration of, in blood and other tissue fluids, 1175
- mode of action of, 1163
- pharmacology of, 1163
- renal obstruction due to crystalline deposits in therapy with, 1171
- toxic complications of, 1170
- use of, in preoperative preparation and postoperative care in uretero-intestinal anastomosis, 1169, 1335, 1336
- in prophylaxis against gonorrhea and chancroid, 719
- Supernumerary kidney, 1365, III 1366
- testicle, 376

- Suprapubic cystostomy, 1105, 1150  
 preliminary to prostatectomy, 883, 886, 891  
 technic of, 886, 1105, III 1103, 1104  
 lithotomy, 1125  
 prostatectomy (see Prostatectomy)  
 suction cup, 1151, III 1151, 1152  
 drainage, 1150, III 1150, 1153
- Syphilis, 266  
 chancre (primary lesion) of, 266  
 in urethra, female, 765  
 male, 637, 638, 765  
 vagina, 597  
 on penis, 266, 301, III 277  
 differential diagnosis of, 259, 263, 270, 279, 283, 415  
 scrotum, 417  
 vulva, 585
- dark field examination in, 268, 298  
 determining freedom from, 276  
 etiology of, 267  
 of bladder, 117, 1023  
 kidney, 1512 III 1513  
 penis, 266 295, 297, III 277  
 prostate, 820  
 scrotum, 417, 418  
 seminal vesicle, 547  
 testicle and epididymis, 445, 459, III 447  
 ureter, 1247  
 urethra, female, 765  
 male, 637  
 vagina, 597  
 vas deferens, 532  
 vulva, 585
- treatment of, 270  
 drugs used in, 271  
 general requirements of, 273  
 with hyperpyrexia and chemotherapy, 276
- Wassermann test in, 268
- Tabetic bladder, 1135, III 989, Plate III
- Teratoma of testicle, 44, 451, 453, 459, 461, 498, 1736, III 454, 455
- Test, Albarran's experimental polyuria, 50  
 Ambard's excretion retention, of renal function, 62  
 McLean's modification of, 62  
 Benedict's, for sugar in urine, 31  
 complement fixation, for echinococcus renal disease, 1523  
 gonorrhea, 707, 716, 727, 765  
 Corper's crystal violet potato, for tubercle bacilli in urine, 42  
 erythrocyte sedimentation, 67  
 Febling's, for sugar in urine, 31  
 for acetoneuria, 32  
 diaceturia, 32  
 Frei, for lymphogranuloma venereum, 293, 597  
 Galatest, for sugar in urine, 31  
 guinea-pig, for urinary tuberculosis, 42, 1028, 1503, 1504  
 heat and acetic acid, for albumin in urine, 30  
 hormonal, for early pregnancy, 43  
 tumor of testicle, 44, 451, 453, 459  
 indigo-carbune, of renal function, 49, 121, 1388  
 intradermal, for echinococcus renal disease, 1524  
 inulin, of renal function, 1387  
 Koranyi's cryoscopy, of renal function, 66  
 methylene blue, of renal function, 48  
 Mosenthal diet, of renal function, 49  
 nitrazine, for pH of urine, 33  
 phenolsulphonphthalein, of renal function, 46, 121  
 phloridzin, of renal function, 49  
 precipitin, for renal echinococcus disease, 1523  
 Reenstierno skin, for chancroid, 262  
 seven-glass, of urine, 26  
 three glass, of urine, 24  
 two-glass, of urine, 24  
 urea-clearance, 64  
 urease, for urea nitrogen, 52, 57  
 urine-concentration, 52  
 urine-dilution, 52  
 Wassermann, 268  
 Wolbart's five glass catheter, of urine, 25
- Tests of blood for calcium, inorganic phosphorus and phosphatase, 60, 61  
 carbon-dioxide combining power, 61  
 creatinine, 60, 61  
 non protein nitrogen, 59  
 urea nitrogen, 57, 64  
 of renal function, combined excretion retention 62  
 excretion, 46, 121  
 retention 52  
 of urine, animal inoculation, 42  
 bacteriological, 23, 41, 42, 120  
 chemical 30  
 clinical, 24  
 glass 24  
 microscopic, 35  
 physical, 27
- Testicle, absence, congenital, of, 376  
 adenocarcinoma of, 454 461  
 anatomy of, 367  
 anesthesia for surgery of, 218, 486  
 anomalies, congenital, of, 376  
 arteries of, 370  
 atrophy of, 371, 379, 388, 409, 413, 434, 435, 473, 475  
 autolysis of, 410  
 blood supply of, 370  
 carcinoma of, 454, 461, 498, 1736  
 chononepithelioma of, 454, 455, 459, Frontispiece  
 contusion of, 405, 407  
 descent of, 363  
 influence of hormones on, 364, 379, 478  
 diseases of, 433, 477  
 ectopic, 364, 376 477, III 494  
 operative treatment of, 379, 487, 493, III 495-499

- Testicle, embryology of**, 361  
 gangrene of, 413  
 gumma of, 446, 459  
 herniation of, 400, 401, 408  
 hormones of, 364, 379, 386, 388, 392, 478, 908  
 inflammations of (see Orchitis)  
 injuries of, 405  
 innervation of, 371  
 interrelation of, and other endocrine glands, 390  
 luxation of, 409  
 lymphatics of, 373, 499  
 lymphogranulomatosis (Hodgkin's disease) of, 462  
 microscopic structure of, 361, 368  
 morphological rests of, 361, 375  
 neuralgia of, 449  
 non-descent of (see Cryptorchidism)  
 non-operative treatment of, 517  
 operative treatment of, 486  
 palpation of, 19  
 physiology of, 385  
 postoperative care following surgery of, 494, 497, 499, 512, 513, 517  
 preoperative preparation for surgery of, 486  
 radiation therapy of tumors of, 387, 462, 1736  
 rupture of, 407  
 secretion of, 369, 385, 386  
 seminoma of, 451, 453  
 supernumerary, 376  
 supports of, 374  
 syphilis of (see Syphilis)  
 teratoma of, 41, 451, 453, 459, 461, 498, 1736, Ill 454, 455  
 torsion of, 411, 413, 437, 487, 495  
   operative treatment of, 495  
 transplantation of vas to, following epididymectomy, 501, Ill 506  
 tuberculosis of (see Tuberculosis)  
 tumors of (see Tumors)  
 undescended (see Cryptorchidism)  
 veins of, 370  
 wounds of, 405, 407  
**Three-glass test of urine**, 24  
**Thrombo-angitis obliterans of spermatic vessels**, 450  
**Torek technic of orchidopexy**, 490  
**Torsion of hydatid of Morgagni**, 414  
 testicle, 411, 437, 487  
   etiology of, 437  
   treatment of, 413, 495  
**Total perineal prostatectomy (see Prostatectomy)**  
**Transperitoneal nephrectomy**, 1668, Ill 1667, 1668  
   pyelotomy in ectopic kidney, 1683, Ill 1681-1683  
**Transplantation of ureters to intestine (see Anastomosis, uretero-intestinal)**  
   to skin in exstrophy of bladder, 1123  
   urethra to penneum following amputation of penis for carcinoma, 332, Ill 329, 330, 331  
   vas to skin of groin following epididymectomy, 445, 502, 510, Ill 503-505  
   to testicle following epididymectomy, 504, Ill 506  
**Transurethral resection of bladder tumors**, 1147  
   median bar, 844 910  
   prostate gland 909, 1747, Ill 1748  
   anesthesia for, 879  
   control of hemorrhage in, 911, 917  
   indications for, 852, 881, 882, 901, 910, 932, 935  
   instruments for, 912, Ill 913-919  
   postoperative care following 917  
   complications of, 917  
   preliminary preparation of patient for 880 911  
   technic of, 915  
   vasectomy preliminary to, 911  
**Tnchomonas vaginalis infestation of bladder**, 1036  
   prostate, 824  
   urethra male 641  
   vagina 595 596  
**Trigonum vesicae** 953, Plate I  
   anatomy of, 949, 951  
   embryology of 944 946  
   hypertrophy of, 1065, Plate V  
   excision of, 1067, 1145, Ill 1145  
   innervation of 971  
**Triphication of ureter**, 1218  
**Tuberculosis of bladder**, 1026, 1497 Plate III  
   diagnosis of 1028  
   treatment of, 1029, 1196, 1324  
**Cowper's gland**, 739  
**Kidney**, 1487, 1631  
   acute military 1492, 1511, 1632  
   autonephrectomy in, 1498  
   clinical lesions of, 1494, 1500 1507  
   diagnosis of, 1500  
   etiology and pathogenesis of, 1488, 1631  
   nephrectomy for, 1664 1666, Ill 1665  
   pathology of, 1492, Ill 1495, 1497  
   postoperative care in, 1196, 1510  
   complications in 1510  
   preclinical lesions of, 1493 1500 1507  
   roentgenography in, 155, 1505 Ill 158  
   symptoms of, 1498  
   treatment of, 1196 1507, 1532  
**penis** 287  
   differential diagnosis of, 279, 283 288  
   treatment of, 288  
   prostate, 821, Ill 822  
   etiology of, 440, 547, 821  
   pathology of, 823  
   treatment of, 510, 824, 920, 1196  
**seminal vesicle**, 547, 822, 823  
   etiology of 440, 547  
   treatment of, 510 548, 1196

- testicle and epididymis, 440, 477, III 442  
 differential diagnosis of, 444  
 etiology of, 440, 482  
 treatment of, 445, 502, 510, III 503-505
- ureter, 1151, 1497  
 operative treatment of, 1324, 1366, III 1325-1328
- urography in, 155, 1251; III 158
- urethra, female, 766  
 male, 639  
 treatment of, 641
- urinary tract, culturing urine for, 42, 1503, 1504  
 diet in treatment of, 1193, 1198  
 erythrocyte sedimentation test in, 67  
 guinea pig inoculation test for, 42, 1028, 1503, 1504  
 staining urinary specimens in, 37, 1508
- vagina 596
- vas deferens, 532, III 531
- vuiva, 585
- radical removal of genital tract for, 510
- treatment of inoperable and postoperative urogenital, 1196  
 constitutional, 1197  
 urological, 1196  
 with quartz light irradiation, 1198, 1199  
 with tuberculin, 1198
- Tuberculous meningitis, 1511
- Tumors of adrenal gland, cortical, 1575  
 operative treatment of, 1578  
 medullary, 1579  
 operative treatment of, 1581
- bladder, 1037, 1157  
 age and sex incidence of, 1030  
 benign, 118, 1038, 1039, 1045, 1046, 1055  
 classification of, 1038  
 cystogram and aerogram in, 174, 1054  
 cystoscopic appearances of, 1053, Plate IV  
 diagnosis of, 1053  
 etiology of, 1050  
 in children, 1092  
 in diverticulum, 1049, 1059, III 1112-1114  
 malignant, 9, 118, 1038, 1041, 1048, 1049, 1751, III 1040, 1042-1045, 1054  
 metastasis, extension and recurrence in, 1049  
 originating in urachus, 1059  
 securing biopsy specimen of, 1056  
 with Kirwin rongeur, 107, III 107  
 Lowsley rongeur, 106, III 106  
 treatment of, by fulguration, excision, or electrorsection, 1037, 1057, 1106, 1146, 1147, 1324 1751, 1752, III 1107-1111, 1148, 1149, 1757  
 by radiotherapy, 1057, 1110, 1147, 1850, III 1111, 1148, 1753, 1754, 1757
- Cowper's gland, 742  
 treatment of, by operation and radiation, 743, 1743
- epididymis, 445
- penis, benign, 296  
 malignant, 298, III 301-304  
 differential diagnosis of, 279, 283, 299  
 treatment of, by amputation of penis, 303, 323, III 324-331  
 fulguration, 333, 1735  
 radiation, 303, 1734
- prostate, malignant, 831, 844, 860, 1747, III 847-849, 861-863, 864  
 biopsy of, 851, III 852-855  
 treatment of, 498, 857, 865, 918  
 by castration, 498, 858  
 estrogenic substances 859  
 radiation, 858, 865, 1747, III 1748  
 supervoltage irradiation of testes, 859  
 surgery, 857, 865, 918, 920, 1747  
 transurethral resection, 852, 910, 1747, III 1748
- renal parenchyma, 1561  
 bilateral primary malignant, 1569  
 diagnosis of, 1571  
 hypertension in, 1444 1558  
 in adults, 1561, III 1564  
 histopathology of, 1562  
 pathogenesis of, 1562  
 treatment of, by operation, 1573, 1760  
 radiation, 1573, 1760  
 in children, 1444, 1553  
 treatment of, by operation, 1559  
 radiation, 1560, 1759  
 pyelography in, 159, 1571, III 162, 163  
 transperitoneal nephrectomy for, 1668, III 1667, 1668
- renal pelvis, 1545, III 1546, 1547  
 diagnosis of, 1550  
 histopathology of, 1546  
 treatment of, by operation, 1552, 1758, III 1325-1328  
 radiation, 1553, 1758
- scrotum, benign, 427  
 malignant, 429  
 treatment of, by surgery and radiation, 431, 1736
- seminal vesicle, 550  
 treatment of by operation and radiation, 550, 551, 1739
- spermatic cord, benign, 463  
 malignant, 464  
 treatment of, 464, 1739
- testicle, 368, 445, 451, III 454, 455  
 benign, 452  
 classification of, 453  
 diagnosis of, 456, 458  
 etiology of, 452  
 hormonal test for, 44, 451, 453, 459  
 treatment of, by operation, 461, 498 1736, III 500, 501  
 radiation, 387, 462, 1736

- Tumors, testicular tunics, 465**  
   urachus, 1059  
   ureter, benign, 1252  
     malignant, 1252  
     treatment of, 1257, 1324, 1758, III.  
       1325-1328  
   urethra, female, 103, 769  
     benign, 766  
     malignant, 769  
     treatment of, by operation, 770, 1744  
       radiation, 770, 1744  
   urethra, male, 103, 648  
     benign, 648  
     treatment of, 649  
     malignant, 650, 656, III 652, 653, 654,  
       655  
     treatment of, by operation, 656, 657,  
       1743  
     radiation, 656, 657, 1742  
   vagina, benign, 598  
     malignant, 599  
     treatment of, by operation and radia-  
       tion, 599, 600, 1739  
   vulva, benign, 589  
     malignant, 590  
     treatment of, by operation and radia-  
       tion, 591, 1739  
   Wilms', 1553, 1558, 1569, 1635  
     treatment of, by operation, 1559  
     radiation, 1560, 1759  
**Tunica albuginea, 226, 361, 367, 370, 408,**  
   498  
   tumors of, 465  
   vaginalis, 364, 366, 370, 373  
   hydrocele of, 413, 458, 467, 478, III. 467  
   treatment of, 510, 511, 512  
   traumatic rupture of, in hydrocele, 404  
   tumors of, 465  
**Two-glass test of urine, 24**  
**Typhoid infection of kidney, 1516**  
**Tyrosin in urine, 40**  
  
**Undescended testicle (see Cryptorchidism)**  
**Urachus, 616, 944, 964**  
   cyst of, 966, 967  
   fistula of, 965, 967  
   patent, 964, 967  
   tumors of, 1059  
**Urea clearance, tests of, 64**  
**Urea nitrogen in blood, tests for, 57, 64**  
   in urine, tests for, 51, 64, 120  
**Urease test for urea nitrogen in blood, 57**  
   urine, 52  
**Uremia, 1436, 1446**  
   acute convulsive, 1436, 1439  
   chronic retention, 1437  
   treatment of, 1438  
**Ureter, 1208, 1232, 1302**  
   actinomycosis of, 1249  
   anastomosis of, 1304, 1316, 1317, 1320  
   anatomical narrowings of, 1211  
   anatomy of, 1210  
   anesthesia for surgery of, 219, 1302  
   anomalies, congenital, of, 145, 1213  
   operative treatment of, 1225, 1302  
   antiperistalsis of, 1228  
   arteries of, 1212  
   atonic, 136, 1228, 1291, 1293, 1412  
   bifurcation of, 150, 1214, 1215, 1221, 1224,  
     1257, III. 149, 1366  
     operative treatment of, 1225, 1302  
   bilharziasis of, 1248  
   blood supply of, 1212  
   calculus of (see Calculus)  
   carcinoma of, 1252  
     treatment of, 1257, 1324, 1758, III.  
       1325-1328  
   catheterization of, 83, 87, 118, 122, 123,  
     1715  
   dilatation, congenital, of (see Megalo-  
     ureter)  
     due to obstruction (see Hydro-ureter)  
     instrumental of, 1197, 1276, 1717  
   diseases of, 1239, 1293  
   displacement of, 1219  
   diverticulum of (see Diverticulum)  
   duplication of, 150, 1214, 1215, 1221,  
     1223, III. 146, 149, 1216-1218  
     operative treatment of, 1225, 1302  
   echinococcus disease of, 1250  
   ectopic orifices of, 629, 750, 1220, 1223,  
     1225, III. 1216, 1218  
     operative treatment of, 1226, 1303  
   embryology of, 1208, 1346  
   fistula of, 1234, 1235, 1237, 1269  
   gonorrhea of, 1246  
   granuloma of, 1244  
   gumma of, 1247  
   injuries of, 170, 1232, 1236, 1412  
     treatment of, 1238, 1315, 1316  
   innervation of, 1212  
   kinks and angulations of, 136, 151, 154,  
     1219, 1222, 1223, 1224, 1277,  
     1294, 1627 III 153  
     treatment of, 1279  
   leukoplakia of, 1246, 1252  
   lymphatics of, 1212, 1452  
   musculature of, 1211  
   non-specific infections of, 1239  
   obstructions of, 1270  
   operative treatment of, 1302  
   palpation of, 15  
   papilloma of, 1252, 1257, 1758  
   peristalsis of, 145, 1226, 1310, 1313  
   physiology of, 1226  
   polyps of, 1253, III 1253  
   postoperative care following surgery of,  
     1169, 1314, 1335  
   preoperative preparation for surgery of,  
     1302  
   prolapse of, 1286, 1290  
   reimplantation of, into bladder, 1303, 1316,  
     1318, III. 1319  
   rupture of, 170, 1232, 1315  
   sarcoma of, 1252  
   spasm of, 1275, 1412  
   specific infections of, 1246  
   stenosis of (see Stenosis)  
   stricture of (see Stricture)  
   syphilis of, 1247



- transplantation of, into intestine (see Anastomosis, uretero-intestinal)
- triphication of*, 1218
- tuberculosis of (see Tuberculosis)
- tumors of, 1252, 1257
- veins of, 1212
- wall of, structure of, 1211
- wounds of, 1232
- Ureterectomy, 1324, 1667, 1669
- with removal of bladder wall surrounding ureteral orifice, 1324, Ill 1325-1328
- Ureteritis, gonorrheal, 1246
- non specific, 1239
- granulosa, 1244
- Ureteritis cystica, 1240, 1244, Ill 1242, 1243
- Ureterocele, 118, 1220, 1285, 1294, Ill 1217, Plate VI
- etiology of, 1286
- treatment of, 1289
- by fulguration, 1290, Ill 1287
- Uretero-intestinal anastomosis (see Anastomosis)
- Ureterolithotomy, 1269, 1270, 1320
- perineal, 1321, Ill 1321
- vaginal, 1323
- Ureteroneocystotomy, 1303
- Ureteropelvic junction non-calculous obstructions of, 1279
- diagnosis of, 1282, 1309, 1313
- due to aberrant renal vessels, 1224, 1272, 1279, 1280, 1283, 1309, 1312, Ill 1280, 1410
- fibrous bands or adhesions, 1272, 1279, 1410
- high insertion of ureter, 1282, 1309, 1311
- hypertrophy of ring muscle, 1309
- structure, 1282, 1283, 1305, 1309
- operative treatment of, 1283, 1303
- by Fenger procedure, 1307, Ill 1307, 1309
- Foley Y plasty, 1309, 1311, 1313
- Rammstedt procedure, 1309
- ureteropyeloneostomy, 1311, 1312, 1313
- prolonged nephrostomy drainage and ureteral spinting in, 1311, 1312
- postoperative care following plastic surgery for, 1314
- symptoms of, 1282
- Ureteropyeloneostomy, 1311, 1312, 1313
- Ureterovesical orifice 1211, 1228, 1291
- enlargement of, by fulguration or cystoscopic scissors, 1269, 1277
- stenosis of, 151, 1219, 1220, 1272, 1284, 1294, 1296
- treatment of, 1269, 1276, 1277, 1304, Ill 1305
- Urethra, female, 748, 755, 781
- absence, congenital, of, 751
- anatomy of 749
- anesthesia for surgery of, 217, 781
- anomalies, congenital, of, 751
- arteries of, 750
- calculus of, 776, 777
- carcinoma of, 103, 769
- treatment of, 770, 1744
- caruncle of, 103, 767, 770
- chancre, syphilitic of, 765
- crista urethralis of, 749
- crypts of, 750
- dilatation, instrumental, of, 759, 764, 772, 777
- diseases of, 757, 777
- diverticulum of (see Diverticulum)
- duplication and bifurcation of, 751
- ectopic ureteral orifices in, 752, 777
- embryology of, 569, 748
- fibroma of, 769
- fistula of, communicating with vagina, 756
- repair of, 784, Ill 784, 785
- glands of, 749, 750, 755 756, 757, 758, 760
- gonorrheal infection of 755 759
- granulomas of, 758, 759, 768
- injuries of, 755, 756
- innervation of, 750 769
- lacunae of, 757, 758
- lymphatics of, 615, 750
- meatus of, 750, 765, 771, 773
- stenosis of, 751, 752, 755
- musculature of, 750, 969
- myoma of, 769
- non specific infections of, 755, 759
- operative treatment of, 781
- papilloma of, 766
- physiology of, 753, 968
- polyps of, 758, 759, 766
- postoperative care following surgery of, 785
- preoperative preparation for surgery of, 781
- prolapse of, 103, 755, 756, 773, 777, 783
- sarcoma of, 770
- stricture of (see Stricture)
- tuberculosis of, 766
- tumors of (see Tumors)
- urethrography in lesions of, 183, 772, 775, 776
- urethroscopic appearance of, 103
- valves, congenital, of, 752, 777
- veins of, 750
- Urethra, male, 607, 632, 672
- abscess of, 644, 645
- absence, congenital, of, 615
- accessory, 626, Ill 627
- excision of, 628, 696, Ill 694
- adenoma of, 648
- anatomy of, 226, 610
- anesthesia for surgery of, 217, 672
- angoma of, 649
- anomalies, congenital, of, 102, 615
- atresia of, 616
- burns of, 633
- calculus of (see Calculus)
- carcinoma of (see Carcinoma)
- catheterization of, 74, 77, 78

- Urethra, chancre, syphilitic, of, 637, 638  
   cylindrical syphiloma of, 638  
   cyst of, 645, 648  
   dilatation, instrumental of, 661, 673, 676,  
     685, 699, 722, 746, 816  
   diseases of, 637, 667  
   diverticulum of (see Diverticulum)  
   duplication of, 626  
   ectopic ureteral openings into, 629  
   embryology of, 225, 607  
   epithelioma of, 650, 656, 1742, Ill 652,  
     653, 654 655  
   examination of, with bougies, sounds, etc.,  
     71  
   fibroma of, 649  
   fistula of, 647, Ill 647  
     communicating with perineum, 738 740  
     excision of, 691, 693, Ill 689, 690  
     communicating with rectum repair of,  
       694, Ill 691-693  
   foreign body in, 632  
   glands of, 613, 614, 644, 709, 710, 711, 722  
   gonorrheal infection of, 701  
   gumma of, 639  
   imperforate, 616  
   injuries of, 632  
     operative treatment of, 679, Ill 680,  
       681, 682, 683  
   innervation of, 969  
   lacuna magna of, 102, 613  
   lymphatics of, 325, 615  
   meatus of, 226, 613, 663, 673  
     accessory, 628  
     atresia of, 616  
     stenosis of, 617, 663, 673  
   musculature of, 612, 613, 614, 968, 969  
   myoma of, 649  
   non specific infections of, 643, 717  
   operative treatment of, 672  
   papilloma of, 648  
   physiology of, 629, 968  
   polyps of, 648  
   postoperative care of, 699  
   preoperative preparation for surgery of,  
     672  
   prostatic duct openings into, 610, 792  
   rupture of, 634, 679  
     operative treatment of, 637, 679, 684  
       Ill 680-683  
   sarcoma of, 656, 668  
   sphincter, external, of, 614  
   stricture of (see Stricture)  
   syphilis of, 637  
   trichomonas vaginalis infestation of, 641  
   tuberculosis of, 639  
   tumors of (see Tumors)  
   urethrograms in study of, 172, 176, Ill  
     178  
   urethroscopic appearance of, 101  
   examination of, 87  
   valves, congenital of posterior, 617, 618,  
     1284, Ill 618, 619, 622  
     treatment of, 624, 683  
     with resectoscope, 686, Ill 686, 687  
   wounds of, 632
- Urethritis, gonorrheal, in female, 755 759  
   male, 701  
   non specific, in female, 755, 757  
   male, 643, 717
- Urethrocele, 756 774  
   treatment of, 776
- Urethrography, injection, 172  
   contrast media for, 172  
   in female, 183  
   technic of, 175  
   uses of, 176
- Urethropenineal fistula (see Fistula)
- Urethroscopes and cysto urethroscopes, care  
   of, 111  
   types of, 87
- Urethroscopy, 87  
   anesthesia for, 100  
   in children, 122  
   indications for, 100  
   instruments for, 87 122  
   preparation for, 100  
   technic of, 101
- Urethrotome, Maisonneuve, 674
- Otis, 674
- Urethrotomy, external, 662, 667  
   technics of, 675, 676  
   internal, 662, 773  
   technic of, 674
- Urethrovaginal fistula (see Fistula)
- Urinary antiseptics, 1162, 1177  
   in cystitis, 1006 1007  
   kidney infections, 1471, 1472, 1611  
   neurogenic vesical dysfunction, 1088
- Urination (see Micturition)
- Urine, acetone in, 32  
   albumin in tests for, 30  
   animal inoculation tests of, 42  
   bacteria in, 37  
   bacteriological tests of, 23, 41, 42, 120  
   Benedict's test for sugar in, 31  
   blood in (see Hematuria)  
   casts in, 40  
   chemical tests of, 30  
   chyle in, 28  
   clinical tests of, 24  
   color of, 27  
   collecting specimens of, 21  
   from individual kidney, 118  
   concentration test, 52  
   connective tissue fibers in, 36  
   crystals in, 28 35, 40  
   due to sulfathery, 1171  
   cystine in, 29 40  
   diacetic acid in, 32  
   dilution test, 52  
   diversion of, in urogenital surgery, 334,  
     637, 781, 786  
   epithelial cells in, 36  
   examining unstained specimen of, 39  
   extraneous structures in, 41  
   extravasation of (see Extravasation)  
   fat globules in, 40  
   Fehling's test for sugar in, 31  
   Galatest for sugar in, 31  
   glass tests of, 24

- hydrogen ion concentration of (see pH)  
 incontinence of (see Incontinence)  
 leucin in, 40  
 microscopic examination of, 23, 25, 35, 120  
 odor of, 29  
 organized sediments in, 40  
 parasites and ova in, 28, 37  
 pH of, 32, 120  
   methods of determining, 33  
 physical tests of, 27  
 preservatives for, 22  
 quantity of, 29  
 reaction of, 32  
 residual, 81, 171  
 shreds in, 29  
 specific gravity of, 30, 50  
 staining specimens of, 37, 38, 120  
 sugar in, tests for, 30  
 tyrosin in, 40  
 unorganized sediments in, 39  
 urea nitrogen in, tests of, 51, 120  
 Urography (see Excretory, Retrograde)  
 Urological examining and treatment tables, 96  
   case history, 1  
 Urticaria of penis, 256  
 Uterus masculinus (see Utricle prostatic)  
 Utricle, prostatic, 361, 522, 609, 611, 787  
   cysts, congenital, of, 625, 825, Ill 625  
 Uvula vesicæ, 949
- Vaccine therapy of bladder, 1195  
   gonorrhea, 725  
   kidney, 1473  
   prostatitis, 817, 937  
   seminal vesiculitis, 546, 567
- Vagina, absence of, 577  
   adenomyoma of, 599  
   anomalies, congenital of, 577  
   atresia of, 577, 581, 595, 598  
   carcinoma of, 599, 1740  
   chancroid of, 597  
   chorionepithelioma of, 600, 1740  
   condyloma acuminata of, 597  
   condyloma lata of, 597  
   cysts of, 598  
   diseases of, 594  
   duplication of, 577  
   embryology of, 570  
   fibroma of, 599  
   gangrene of, 595  
   gonorrheal infection of, 591, 592, 594, Ill 593  
   inflammations of, 594  
   injuries of, 581  
   lipoma of, 599  
   lymphogranuloma venereum of, 597  
   polyps of, 598  
   radiation therapy of tumors of, 599, 1739  
   removal of ureteral calculus through, 1323  
   sarcoma of, 600, 1740  
   stenosis of, 598  
   syphilis of, 597  
   trichomonas vaginalis infestation of, 595, 596
- tuberculosis of, 596  
 tumors of (see Tumors)
- Vaginismus, 598, 600  
 Vaginitis, 594  
   treatment of, 595
- Valves, congenital of posterior urethra, 102, 617, 618, 1284, Ill 618, 619, 622  
   diagnosis of, 623  
   etiology of, 621  
   in female, 752, 777  
   treatment of, 624, 685  
     with resectoscope, 685, Ill 686, 687
- Varices of bladder, 117  
   vulva, 582
- Varicocele, 371, 471  
   treatment of, 472, 514  
     by injection, 515  
     operation, 516
- Varicocelelectomy 516
- Vas deferens 373, 521, 529, 556  
   ampulla of, 521, 523, 525  
   calcification of, 532, Ill 534  
   anastomosis of, 559, Ill 559  
   anatomy of, 522  
   anesthesia for surgery of, 218, 556  
   anomalies, congenital, of, 526  
   arteries of, 524  
   diseases of, 529, 553  
   embryology of, 361, 521  
   gonorrheal infection of, 529  
   injuries of, 408, 529  
   innervation of, 372, 373, 524  
   lymphatics of, 373  
   non-operative treatment of, 562  
   non specific infection of, 530  
   operative treatment of, 486, 556  
   palpation of, 19  
   physiology of, 526  
   preoperative preparation for surgery of, 556, 560  
   stricture or occlusion of, 475, 477, 532  
   syphilis of, 532  
   transplantation of, to skin of groin following epididymectomy for tuberculosis 445, 502, 510, Ill 503-505  
     testicle following epididymectomy, 504, Ill 506  
   tuberculosis of (see Tuberculosis)
- Vas puncture, 566
- Vasectomy, 557  
   preliminary to prostatectomy, 557, 887, 891  
   transurethral resection, 911  
   technic of 557, Ill 558
- Vasotomy, 556, 566  
   technic of, 557
- Veins of bladder, 956  
   Cowper's gland, 736  
   epididymis 371  
   kidney, 1350, 1358  
     anomalous, 1381, 1383, Ill 1410  
   penis, 228, 356  
   prostate, 797  
   scrotum, 366  
   seminal vesicle, 525

- Veins, testicle, 370  
   ureter, 1212  
   urethra, female, 750  
 Vena cava, rupture of, due to retroperitoneal  
   abscess 1481, Ill. 1481, 1482  
 Venereal warts, 234, 296, 301, Ill. 321  
 Verrucae, 296  
 Verumontanum, 527, 799, 812, 915  
   anatomy of, 610, 611, 614  
   embryology of, 522, 609  
   pathological changes of, in seminal vesicu-  
   lus, 539, 544  
   treatment of, preliminary to catheteriza-  
   tion of ejaculatory ducts, 563  
   urethoscopic inspection of, 102  
 Vesical orifice, 949, Plate V  
   contracture of, 842, 1065, Ill. 1066  
   hypertrophy, congenital, of, 964  
   repair of, for cure of incontinence, 1137,  
   Ill. 1138, 1139  
 Vesico-enteric fistula, 1077  
 Vesico-ureteral reflux, 1228  
 Vesico-uterine fistula, 1079  
 Vesicovaginal fistula, 581, 756, 994, 1076  
   operative treatment of, 1128, 1324, Ill.  
   1130-1134  
 Vitiligo of vulva, 589  
 Vulva, adenomyoma of, 590  
   carcinoma of, 590, 591, 1740  
   chancroid of, 586  
   condyloma acuminata of, 587  
   condyloma lata of, 585  
   cutaneous affections of, 581  
   cysts of, 589  
   diseases of, 581, 591  
   elephantiasis of, 587  
   erysipelas of, 584  
   fibroma and fibromyoma of, 589  
   furunculosis of, 583  
   gonorrheal infection of, 585, 591  
   granuloma inguinale of, 586  
   gumma of, 586, 766  
   inflammations of, 583  
   injuries of, 581  
   Vulva intertrigo of, 583  
   kraurosis of, 588  
   leukoplakia of, 588  
   lipoma of, 589  
   pruritus of, 589  
   radiation therapy of tumors of, 591, 1739  
   sarcoma of, 591, 1740  
   syphilis of, 585  
   thrombophlebitis of, 582  
   tuberculosis of, 585  
   tumors of (see Tumors)  
   varicose veins of, 582  
   vitiligo of, 589  
 Vulvectomy, 603, 1740, 1741  
 Vulvitis, chronic hypertrophic, 587  
   follicular, 583  
   gangrenous, 584  
   gonorrheal, 585, 591  
   mycotic, 584  
   puerperal, 584  
 Vulvovaginal glands (see Bartholin's glands)  
 Vulvovaginitis, gonorrheal, in children, 591,  
   Ill. 593  
 Wassermann test, 268  
 Wilms' tumor, 1553, 1569, 1635  
   hypertension in, 1444, 1558  
   pathogenesis of, 1554  
   pathology of, 1556  
   treatment of by operation, 1559  
   by radiation, 1560, 1759  
 Winkelmann operation for hydrocele, 512  
 Wounds of bladder, 986  
   operative treatment of, 988, 1120  
   kidney, 1398  
   penis, 245, 247, Ill. 246  
   scrotum, 400  
   testicle and epididymis, 405, 407  
   ureter, 1232  
   urethra, male, 632  
 Young's method of total prostatectomy, 922  
   operation for penile epispadias, 349, Ill.  
   349